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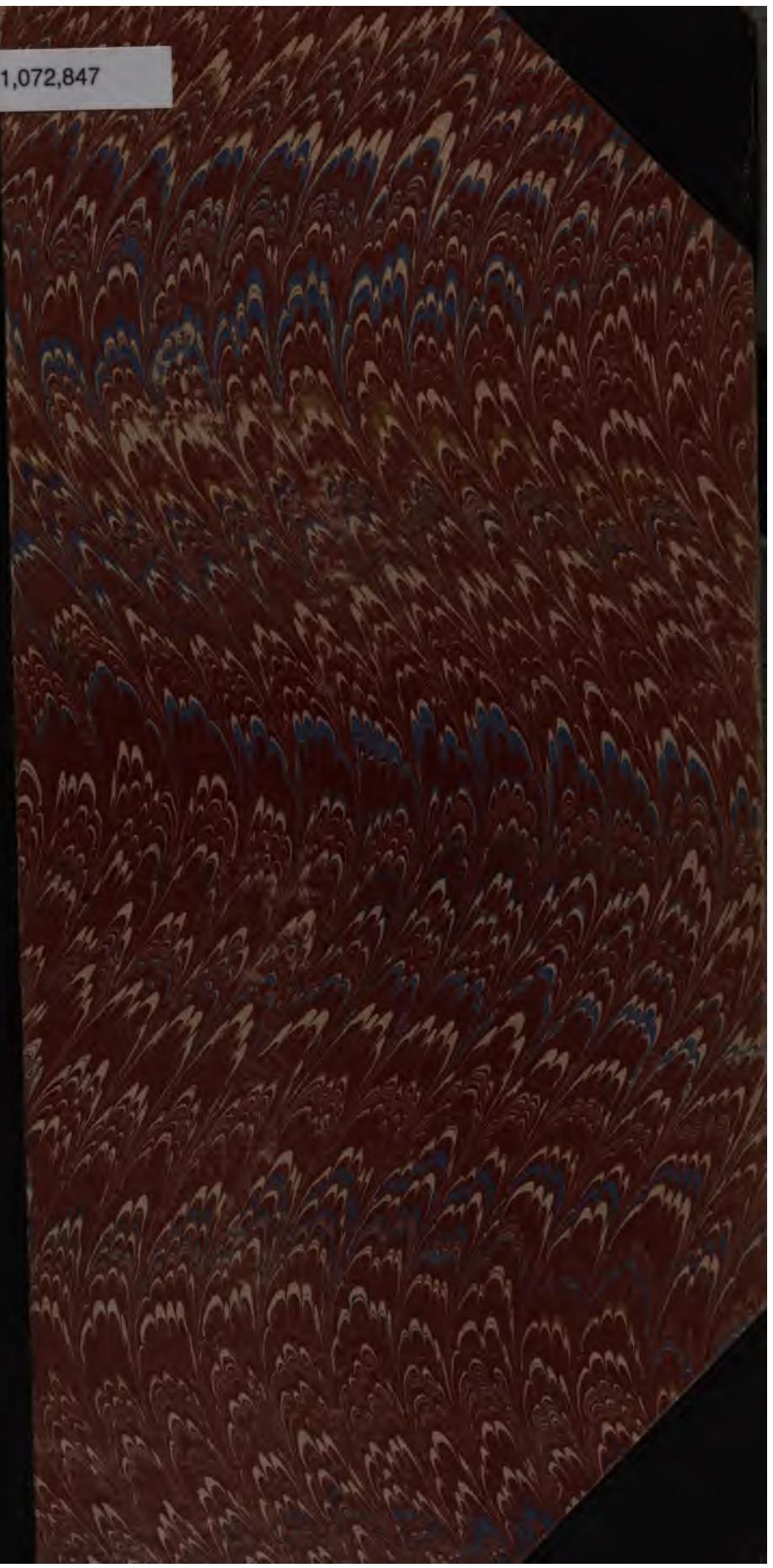
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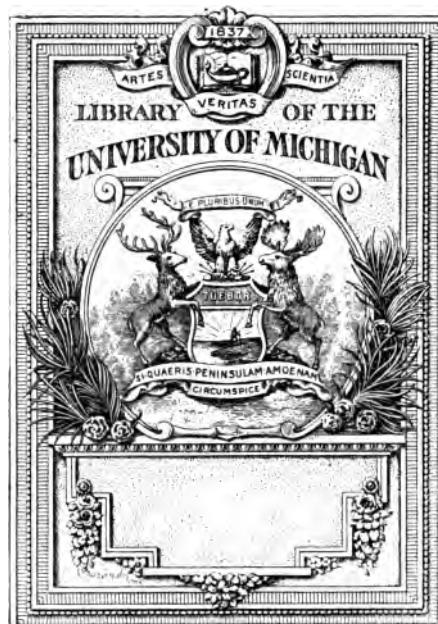
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VOLUME XXI

FOR

1900

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CONTENTS.

Multiple Color Illumination. With Frontispiece.....	1-12
Preserving as Permanent Specimens Casts Found in Urine.....	12-14
Agar-Agar.....	14-19
Photo Micrography with Opaque Objects	19-21
Micrometry of Human Red Blood Corpuscle	21-22
Occidental Sea Specimens.....	22-24
A Kettle-hole in Newark, N. J	24-25
BIOLOGICAL NOTES.—Pannier.—Holdfasts of Certain Florideæ ; Compound Oospore of <i>Albugo bliti</i> ; Vibrioids in the Plant Cell ; Indiaua Plant Rusts ; Notes on Travel ; Comparative Embryology of Rubiaceæ.....	25-28
MICROSCOPICAL SOCIETIES.—Washington ; Royal Microscopical Society ; Quekett Club.....	28-30
NEW PUBLICATIONS.—Moulds, Mildews and Mushrooms ; Botany	30-31
MICROSCOPICAL NOTES.—Card; Slides; Objects ; To Print a Palm	32

Multiple Color Illumination.

JULIUS RHEINBERG.

With Frontispiece.

It is the natural desire of all who possess a microscope to look at their objects to the best advantage. For those who employ the microscope in the pursuit of science, it is a necessity, and for those who use it as a pastime it is equally pleasurable to know that they are seeing as much as can be seen, given their peculiar object and their particular lenses.

Now what is the secret of doing this? It lies simply in the mode of illumination, and I purpose, in this article to treat of some comparatively new methods or illu-

mination particularly calculated to show up numerous classes of objects to great advantage, and which at the same time give very pleasing effects.

It is now some five years since I first began to make experiments with a view to finding out how it might be possible, without staining, to cause an object and its background to appear of different colors, and so secure a greater contrast than usual. Up to the present I have found three different ways by which we can make uncolored objects assume any color we wish, and our background any other color. In many circumstances we can also make definite parts of objects themselves assume different colors—if so desired. These effects may be produced so simply that any amateur may make many of the experiments himself at the cost of a few cents.

In all microscopes fitted with a condenser in the sub-stage, there is, underneath the condenser lenses, a ring or some form of holder to take stops for dark-ground illumination. Now let us cut out a disc of red gelatine (such as is used for crackers) to fit this ring, then punch a hole in the centre about a third of its diameter, and stick over the hole a piece of blue gelatine of the same size (fig. 1a). Then we place this color disc in the holder under the condenser, and use it in the same way as we would use the dark-ground stop. We will suppose we are using a 1" objective. The result to those who have not seen it before will be astonishing. The objects, for instance a slide of *Polycystina*, or some living Rotifers, will appear perfectly red, and the background perfectly blue. The great contrast throws the objects up in a most striking manner. Of course, if we wish to vary our colors, all we have to do is to vary the colors of the gelatine; a yellow disc with a blue centre will show the objects yellow on a blue ground, an uncolored disc with a green centre (fig. 1 b) will show the object white or whatever may be its natural color on a green background, and so forth. We must take care,

however, in making the discs that the central spot which gives the color to the background is comparatively darker than the other part of the disc.

Now we will vary the experiment and make a disc like fig. 1 d, of four sectors; two opposite ones red, the other two blue, and on it paste a black central spot. Using the disc we will look at a small piece of silk mounted in Canada balsam (a morsel of a Japanese silk handkerchief does excellently) and notice the result: It is as if the silk had been woven in two colors—all the horizontal threads composing the warp being blue; all the vertical ones which form the weft being red.

Having made these experiments let us stop and consider the cause of those rather startling results. Why did the object ostentatiously appropriate to itself all the red light, and why did the background appear blue only when we used the disc like fig. 1 a? The answer to the last question is simply that without having an object in the field no red light gets into the microscope tube, because the cone of light admitted by the 1" objective is no larger than the cone of light coming from the condenser through the blue central portion of the color disc, as seen in fig. 2.

The expressions, viz:—"Aperture" of an objective or condenser, and "Cone of Light" admitted by an objective or condenser are of somewhat frequent recurrence in this article. It may be useful to some readers to have these terms explained, an exact comprehension being essential to understand the subject. When we use a condenser we bring the light which passes through it to a focus on the object; and the shape of the passage of light is a cone with its apex at the object and its base the condenser lenses. The cone is represented by the triangle FAB of fig. 2. After passing the focus the light again forms a cone, inverted this time, and the whole or some part of this cone may be taken up by the objective (FXY fig. 2). The cone may be wide or narrow; for instance the cone

FIG. 2 is relatively narrow to the cone FAB. As a matter of fact, condensers are always made of large "aperture," they are always made to give a large cone of light, and it is usual to narrow them down when desired by an iris diaphragm. But objectives are made of fixed "apertures" which differ very greatly, according to the power of the objective, a low power like a 1" objective having an "aperture" much smaller than a $\frac{1}{2}$ " objective for instance—or to put it in other words, the "cone of light" admitted by a 1" objective is relatively small as compared to that admitted by a $\frac{1}{2}$ ".

Now as regards the object, there was light knocking up against it from all sides—partly blue light, partly red—and as we may for our purpose regard an object as a collection of little prisms of various shapes, which turn and twist the light falling on them in various directions according to the law of refraction and reflection, we can easily see that a lot of this light which hit the object, had its direction changed so as to fall within the cone of light admitted by the objective. So that plenty of the red light, which would otherwise have passed outside of the objective, has now been thrown up into it by the object, and depicts the object in that color in consequence. Fig. 3 illustrates this. Of course this has not prevented the blue light also forming an image of the object in blue, but you will notice that the difference in area between the red and blue portion of the disc (fig. 1 a) is considerable, in fact the former is about eight times as great as the latter, and as a consequence the red image will be roughly speaking about eight times as strong as the blue one, which causes the latter to be swamped out as far as the eye is concerned.

We will now proceed to a different method of illumination. The above method was limited to the use of objectives of not higher power than $\frac{1}{2}$ ", but the illumination now to be described, as well as the third method, is ap-

plicable to all objectives, no matter of what power they be.

We will suppose we are looking at some diatoms with a $2\frac{1}{2}$ " objective, and we will put a color disc below the condenser as before, one with a red centre and a green rim this time. The red centre should be of ruby-colored gelatine, which can be easily obtained, but the particular green gelatine for our purpose is difficult to get, and the best thing to do is to buy a little of the stain known as malachite green, dissolve it in alcohol, and then add a little of the dissolved stain to some collodion. A little of the dyed collodion should then be poured over the ordinary green gelatine, which can be bought ready. It quickly evaporates, leaving a thin film of the gelatine of a beautiful blue-green color such as we require.

It is a well-known fact that white light is made up of light of all colors, and that by means of a prism the rainbow colors can be re-combined to form white light. It has also been practically demonstrated by Ives, the inventor of the photochromoscope, how the so-called fundamental colors, viz., green, red, and blue-violet, can be re-combined so as to appear white. But it is not so generally known that, if correctly chosen, two colors only are needed to give the impression of white light to the eye, when combined in the proper ratio. Such however is the fact, and this is the principle we are going to work with. If we can mix the ruby-red light of the central portion of our color disc with the green color of the rim in the right proportion, we can obtain light the color of which to our eye appears almost white. Now the mixing of these colors is exceedingly simple, provided our condenser has an iris diaphragm to it.

Let us look down the microscope with the iris quite open, then the field or background appears quite green, for this time we are using an objective of wide aperture, one which will admit a cone of light much wider than that

proceeding from the central red portion of the disc only, and as already pointed out, when there is a large excess of light of one color over that of another color, the stronger swamps out the weaker. We now gradually close the iris diaphragm, thereby shutting out more and more of the green light, the color of the background will then be seen to change to a fainter and fainter green and a point will be reached where it appears neutral tinted or almost white. *Fig. 4.*

Not so, however, the object; on this white ground the diatom shines forth resplendent in the hues of red and green more or less undiminished in intensity, the ridges and higher structures appear green, the other parts red. For it is clear enough that the different parts of the diatom will not have the red and green light falling upon them or be throwing the light up into the objective in the precise ratio to form white light. The ridges catch a deal more oblique light, which happens to be green, and much of the finer and more transparent structure catches and passes up an excess of red light in the objective. Again, wherever there are very fine perforations or holes in the shells of the diatoms these appear pure red, because so very little of the obliquely falling green light passes through the holes into the objective, and thus to the eye. This enables us to say at a glance and with certainty, that such and such spots are perforations in a membrane, whilst others are small raised prominences, etc., things which in the ordinary way it is exceedingly difficult to determine, and upon which many controversies have been held.

For the best effects with the kind of illumination just described (which *fig. 5* illustrates diagrammatically), the total utilized cone of light from the condenser should fill from two-thirds to three-quarters the aperture of the objective. The way to see whether this is the case is to take the eyepiece out of the microscope and look down the tube, then we can see the back lens of the objective, and

to what extent its aperture or area is filled with light.

Now we will proceed to the third method of multiple color illumination—one which depends upon a quite different set of principles to the other two, viz., on the class of phenomena known as diffraction. But, as before, we will let practice precede explanation. We take some small microscopic cover-glasses of the thinnest kind, choosing them of such a size that we can drop them from above on to the back lens of the objective which we are about to use, say a $\frac{1}{2}$ " or $\frac{1}{4}$ " objective. They must, of course, completely cover the back lens. We transform these little cover glasses into color discs by coating them with stained collodion, for gelatine such as we used for the discs placed under the condenser is not nearly sufficiently clear and homogeneous for the present purpose. The best way to make the stained collodion is to dissolve the dye (fuchsin, methylen blue and malachite green are suitable dyes) in pure alcohol, and then add it to the collodion, which may be bought ready. I would, however, strongly recommend those who wish to make the experiments also to make their own colodion by dissolving a little of Schering's celloidin in equal parts of ether and alcohol. This gives very much better results than the ordinary ready-made collodion. With a pipette or a glass rod we drop the dyed collodion on the little glass circles and let it evaporate, which it does very quickly. Then with a needle we scratch the film off the glass except where it is required. If we want to make a red disc with blue centre, we coat the one side of the glass with a red, the other side with a blue film. All the blue excepting a small central spot about one quarter the diameter of the top lens of the objective is then removed, and on the red side the film is scratched away from the central area to correspond.

Having dropped our little disc into the objective, we first focus the latter on to our object, a section of bone, let us say, or if preferred, we may look at diatoms again, as

there is nothing to compare with these for experimental purposes. Then we remove the object, and carefully focus our coudenser on to the same plane. If the condenser is properly focussed, the back lens of the objective should be filled with light when the eyepiece of the microscope is taken out and we look down the tube. Next, we close the iris diaphragm of the condenser, looking the while down the tube, till all the light is cut off from the red part of the disc, and only just fills the blue central part (fig. 7). Now we can replace the eyepiece, bringing the object in position again, and the object will appear clearly and distinctly red on a blue ground, and we shall notice that the diatoms appear to stand out almost stereoscopically, and that the thicker parts of the bone section, which appear hazy if looked at with the same objective without a color disc, have become much better defined. Of course with a color disc having a blue central spot without the red rim, the object shows up in its natural color on a blue ground. *Vice versa*, if the disc is completely blue with only a central spot uncolored (the size of which, however, must not exceed one-sixth to one-eighth part of the diameter), the object shows up blue on an uncolored ground.

The diffraction of light passing by and through the object is the chief cause of our results in this instance. Without going too deeply into an explanation of diffraction, which would involve discussing the laws of wave motion, I need only mention that whenever a ray of light (R, fig. 6) meets an obstacle (S, fig. 6), this point becomes a centre for waves to spread out from. Now the crests and hollows of all the waves of light produced at this point and in the immediate vicinity intermingle and interact on one another, and thereby become regulated in such a way that one portion of the light, R', travels on undisturbed as a continuation of the original ray, whilst other diffracted rays (D 1, D 2, D 3) are produced (differing only from the last-named one in that they are not

quite so luminous), which proceed from the point of the obstacle at various angles to this direction. The whole forms what is known as a diffraction fan.

In ordinary vision we need take but little account of these diffracted rays, but in vision with optical instruments and especially with the microscope they play a large and fundamental part, for one of the functions of the objective is to collect these rays, starting from a point of the object at different angles, and bring them altogether back into one focus at that spot where an image of that particular point of the object is formed. A peculiarity about diffraction fans is that the smaller the structure which causes them, the more spread out are the component rays of the fan, and that at least two rays must be taken up by the objective to show up the structure at all, except as a sort of indefinable blur.

To return to the color discs, we can now comprehend how any ray (R, fig. 8), gets split up into rays R 1, d 1, d 2; the first one of which passes through the blue part of the disc before being brought to a focus up near the eyepiece, the others through the red part of the disc. The greater number get the best of it, and so the most of the structure appears in red. Of the whole object, only the very coarse structure would appear in blue, because the rays of the diffraction fan produced by this are so crowded together that they all pass through the blue centre of the disc.

Incidentally I may say that by having color discs ground in a peculiar manner, it has been found possible to get the separate images of an object formed by the blue and red portions of a color disc side by side, the one of which shows only the coarsest structure, the other all the finer structure.

Refraction of light also plays some part in determining the color of the object in this third method of illumination, but having dealt with this already in the other

methods, I may leave to the reader's own observation how it acts here.

It is curious to observe that in this method we have employed a comparatively very narrow cone of light from the condenser, with an objective of large aperture, just the exact reverse to what we did in our first method.

That in this method the color of the background is simply determined by the color of the only light which gets into the microscope-objective, when there is no object placed in the path of the light rays (to wit, blue in our example), stands to reason (fig. 7).

It only remains for us now to see where the use of multiple color illumination comes in, and what is its scope. For the pretty results thereby obtainable, though very good in their way, and calculated to call forth expressions of delighted surprise from our non microscopic friends, are not the most worthy object of the microscopist's ambition. To see a ruby-red rotifer disporting itself in a deep green sea, to look at muscle fibres with alternate red and blue bands, in short, to see our objects highly colored, like the Lord Mayor's Show, what is the use?

The use may be summed up by saying that we increase our knowledge of the object by, increased ability to see it and by increased ability to draw conclusions from that which we see. When we go out on a sunny day in the country, we put on a broad-brimmed hat, so that the light of the sun may be kept from our eyes, and we can see the landscape better. If we want to see particularly well we even shade our eyes further by holding our hands up to the brim. That is just what we usually do not do when we look through the microscope, for we gaze at the full glare of our light, and if it is too strong we merely shut some of it off without stopping to distinguish between, or to consider whether, it is image-forming or background forming light; nevertheless we expect our eyes to distinguish all they might be capable of doing.

Again, if we go and take a train, we observe the signal-boxes fitted with red and green lights which long experience has shown that the engine-drivers can distinguish most readily. But in using the microscope we do not usually trouble about the sensitiveness of our eyes to colors; in other words, we are much too apt to forget that whilst our eyes are very sensitive optical instruments, we must pay due regard also to their physiology. This then is the keynote to the way in which multiple color illumination acts in sharpening the vision. We get greater perception of detail, of depth, and of solidity or general form.

At the same time knowing how we have arranged our colored lights to fall upon our objects, and noticing which parts are lighted up in the various colors, we are able to draw additional inferences as to their size—even in matters of wave lengths—as to their shape, and as to whether what we see is the true object, or a false light effect, for such may frequently occur with bad illumination, and have caused innumerable discussions. It is a lesson in microscopic optics in itself to study the appearance of air or oil bubbles in water with different kinds of multiple color illumination, and I may safely say that most readers who experiment with these kinds of illumination will know considerably more about their microscopes after than before.

The scope of multiple color illumination is a large one; it lends itself well to the study of botanical and physiological preparations, to the study of living organisms, to investigations on diatom structure, to commercial purposes, as examining fibres, papers, etc., and to photo-micrography.

It has been my endeavour in this article to convey an idea as to the methods and theory of multiple color illumination in an intelligible manner, without going too much into technicalities, and those who are sufficiently in-

terested in the subject, I would refer to my papers in the journal of the Royal Microscopical Society of 1896, pp. 373-88, and in the *Quekett Club Journal*, 1897, p. 346, and 438.

EXPLANATION OF DIAGRAMS.

Fig. 1. Various Colors Discs.

Fig. 2. First Method of Multiple Color Illumination—No object in the field.

Fig. 3. First Method of Multiple Color Illumination—Object in position.

Fig. 4. Second Method of Multiple Color Illumination—No object in the field.

Fig. 5. Second Method of Multiple Color Illumination—Object in position.

Fig. 6. Diffraction Fan produced by a ray of Light R passing by or through an obstacle S.

Fig. 7. Third Method of Multiple Color Illumination—No object in the field.

Fig. 8. Third Method of Multiple Color Illumination—Object in position. D, Color Disc; C Condenser; S, Object; O, Condenser; G, Iris Diaphragm.

Dotted vertical lines represent the passage of white light. Slanting shading represents dark space.

Preserving as Permanent Specimens Casts Found in Urine.

Generally speaking, all crystalline substances found in urine can be preserved in Canada balsam after allowing them to dry on a slide or cover glass. However, specimens thus mounted are likely to become cloudy in from a few weeks to two years. Shreds of tissue, parasites and their ova, are well preserved when mounted in glycerin, as are unstained bacteria and fungi.

It is far more difficult to make satisfactory mounts of casts, since their general characteristics are so readily de-

stroyed by evaporation or the slightest pressure; and their basement membrane, so to speak, is of such chemical composition as to dissolve when brought in contact with the various mounting media. The ability to destroy all bacteria, especially those capable of producing gas, is of equal importance in selecting a mounting medium. Where the field becomes cloudy, casts disintegrate, or air bubbles appear within a few days or weeks after a specimen is mounted. These changes are commonly due to the development of bacteria. A mixture of the following will be found capable of preserving all forms of casts. Liquor acidi arseniosi (U. S. P.), one fluid ounce; salicylic acid, half a grain; glycerin, two fluid drachms. Warm slightly until solution is effected, when add acacia (whole tears), and again warm until solution is saturated; after subsidence, decant clear supernatant liquid. A drop of formalin (forty per cent) may be added to this mixture if desired.

After all ordinary precautions as to cleanliness are taken in securing the urine, a bottle, previously cleaned, is partially filled, corked tightly, and allow to stand in a cool place until a precipitate collects at the bottom of the liquid. Decant the supernatant urine, add an equal quantity of distilled water to the precipitate, and allowed it to stand until it collects again at the bottom of this liquid. (If a few drops of chloroform are added, urine thus obtained can be kept for days without any change in the casts). The precipitate is lifted by means of a pipette, and a small drop of the thickest of this sediment is placed on the centre of the slide and carried to the microscope, where it can be viewed under a low power. If casts are present, it is evaporated nearly to dryness, when a drop of the above-described medium is added by means of a glass rod to the centre of the drop of urine, and it will be noticed that there is no tendency for these substances to mix; the urine completely surrounds the drop of medium, and in

order to get an equal distribution of casts throughout the field, it is necessary to carry a fine needle from the outer margin of the urine to the centre of the medium until the two substances show no tendency to separate, care being taken lest air bubbles are produced. A cover glass is moistened by the breath and then allowed to fall gently on the specimen. The slightest pressure, or the application of heat, is usually destructive to casts. The slide is now put in a cool place for a few hours, in order that hardening may be complete. A permanent ring of zinc-white has been shown to be of value in the preservation of these specimens. Some illustrative plates were sketched from specimens that had been mounted two years and a half, and show perfectly every feature possessed by casts studied from the same urine after the usual methods employed.—

L. N. Boston, M. D., N. Y. Med. Journal.

Agar-Agar.

W. W. ALLEGER.

The preparation of agar by the older methods is well known to be a tedious operation, which consumes much valuable time. The product obtained is seldom, if ever, quite transparent; while not infrequently troublesome precipitates which not only mar the appearance of the medium but render it unsuitable for the finer classes of work, develop after sterilization.

The use of powdered agar, which has been in the market for two or three years, because of its ready solubility, simplifies the process and greatly shortens the time required in the preparation of the medium; but for some reason, doubtless because of the scant notice which has been given to the matter in the literature, it does not yet seem to have come into general use. To call attention to the powdered form, and report a method for obviating the appearance of secondary precipitates in the tubes, on ster-

ilization, was the object of a paper by the writer published in the first number of the Journal of Applied Microscopy.

The method then described materially lessened the time and labor required in the preparation of agar and gave a perfectly transparent product. Subsequent efforts, aided by a suggestion obtained from an article by Dr. Ravanel, in the June number of the Journal, have enabled us to shorten the time limits from two and one-half hours to one hour, counting from the time of the receipt of the meat in the laboratory until the last drop of the completed medium has passed through the filter, and yet obtained average results; while by deferring filtration until after the first sterilization a perfectly transparent medium is obtained. In the latter event from half to three-quarters of an hour suffices for the initial preparation, exclusive of the time required for sterilization in bulk, but a half hour more is required on the following day for re-heating and filtering. The process is as follows:

Rub up 10 grams each of powdered agar and Witte's powdered peptone, and 5 grams of sodium chloride, in a porcelain-lined saucepan, with just sufficient water to thoroughly moisten the powder and form a thin paste; add gradually, while stirring the mixture, 500 cc. of water; place on a gas stove, interposing a piece of asbestos board or wire gauze between the saucepan and flame, and heat the mixture until the agar is dissolved, stirring occasionally to prevent burning on the bottom of the dish. If the paste made with cold water is properly rubbed up, so as to break down all the lumps and moisten all the agar, solution will be practically complete by the time the boiling point has been reached, so that two or three minutes brisk boiling suffices.

With the aid of a meat press extract the juice from 500 grams (one pound) of lean meat, and add the juice to 500 cc. of water. Mix this "fresh-water" with the agar solu-

tion—which now should have cooled sufficiently not to coagulate the albumin in the fresh-water, but still be hot enough to remain fluid—and carefully neutralize with a 4 per cent solution of caustic soda.

After neutralization boil the mixture until all the coagulable albumin in the fresh-water has been coagulated and comes to the surface, leaving a clear fluid beneath. Again test the reaction, and, if need be, correct it; add sufficient boiling water to supply any loss that may have occurred through evaporation, and filter through paper. To insure rapid and complete filtration without the necessity of reheating the mass I distribute the solution in three or four filters, using coarse, folded paper, pass sufficient boiling water through each filter to wash away loose lint and thoroughly heat the funnels just previous to commencing the filtration of the agar. With good paper and proper attention to detail filtration is usually accomplished in from ten to fifteen minutes.

While filtration is in progress sterilize or boil a tube of the filtrate. If it remains clear after heating, and when cold is free from sediment and only slightly opalescent, the entire filtrate may be immediately run off into tubes and sterilized. But if a precipitate should make its appearance either on heating or while cooling, the filtrate should be sterilized in mass and allowed to stand in the sterilizer with the light turned low or out until the precipitate collects together at or near the bottom of the flasks when the agar may be reheated and refiltered; this time, with the confident expectation that the filtrate will be and will subsequently remain transparent. Or, if preferred, the agar may be run off into cylindrical deposit glasses, sterilized therein, and allowed to stand in the sterilizer, as before, until the sediment has settled to the bottom after which the clear fluid may be syphoned off, or allowed to cool and cut off with a knife and the portion containing the sediment be discarded, or filtered.

Usually, on account of the liability to secondary precipitates, and because the agar is never so transparent when filtered immediately as it is when the filtration is deferred until after the first sterilization, I do not filter at once, but merely strain out the coarser flocculi by running the medium through loosely packed cotton, sterilize in flasks, allow the flasks to stand in the sterilizer and slowly cool, and wait until the following day before filtering through paper. Filtration is then still more rapid, if care is taken to bring the temperature of the mass up to the boiling point in the sterilizer before commencing the filtration, and the product is always transparent.

The coarser precipitates which occur on sterilization are usually due to the coagulation of albumin which has escaped coagulation at the time of the preparation of the medium; but the troublesome ones are of more doubtful origin; probably they consist, in the first place, of very fine flocculi which pass through the filter on the first filtration, and, in the second place, of salts which are held in solution during the first filtration but which as a result of changes in the reaction, oxidation, or because of lessened solubility in the cold medium and their presence to supersaturation, are deposited as the medium cools. But whatever their nature and cause I have been unable to avoid their appearance altogether save by the method just detailed. When present in only small amount and sterilization is not too much prolonged, (ten minutes) if the tubes are *quickly* cooled they cause no perceptible sediment and only a slight opalescence in the finished product and are then really not objectionable, though I always prefer to have my media perfectly transparent if possible.

Eggs are not needed to clear the agar when made by the above process, the albumin in the meat juice being sufficient for the purpose.

If it be desirable to make agar from bouillon it is only necessary to rub up the powdered agar with a little of

the cold bouillon to a paste and then gradually add the balance of 500 cc. thereof, and boil until solution—which quickly takes place—is complete; add the balance (500 cc.) of the bouillon; stir in the whites of two eggs and boil until the egg albumin is coagulated and rises to the surface leaving the clear solution beneath, and then filter, as before. As, however, the agar can be made from the flesh-water almost as readily and quickly as from the bouillon there is little use for previously prepared bouillon.

Meat extract can also be substituted for the flesh-water. Formerly I used from 20 to 30 cc. of Valentine's meat juice per liter, but more recently I use but 10 to 15 cc. which quantity I find sufficient. I prefer Valentine's to other extracts that I have tried as it makes a lighter colored agar and seems to be free from resistant spores, as no more care is required in the sterilization of the media made from it than from meat itself. If 10 cc. of meat extract (or meat juice as Valentine terms it), be added to 500 cc. of water and substituted for the flesh-water the process is the same as with the latter, save that egg albumin must be added to clear the medium if it be desired to filter before sterilization. Meat extract, is more convenient than meat for making media, but some organisms do not seem to thrive so well upon the media thus made.

The precaution of first moistening the agar and peptone with a small quantity of cold water or cold bouillon, as the case may be, and rubbing to a smooth paste free from lumps, must not be omitted. If stirred directly into a hot solution—and to a less extent if stirred directly into a large quantity of cold water, without previous moistening—the agar rolls up into little lumps and is almost as difficult of solution as the finely cut pieces of shred agar.

If a meat press is not at hand the flesh-water can be made in the ordinary way either by macerating finely minced meat in cold water for a few hours, or by digesting for a shorter time at a higher temperature.

Photo-Mircography With Opaque Objects.

W. H. WALMSLEY.

Any microscope, with or without inclination to body, may be used. The results are better with, than without any ocular, and the latter should be, if possible, especially constructed for the purpose—as Zeiss' projection eyepiece for example. It should be capable of carrying and focusing a three-inch objective, which power is useful for many comparatively large or coarse objects. The outfit of lenses should include a two-inch objective but need not go above, 1-5 the most useful work being done with 1½-in. to ½-in. A plano-convex or bull's eye condensing lens on stand is indispensable. If possible, a Lieberkuhn for each objective and a parabolic silvered reflector should be included in the outfit, though the latter pieces of apparatus are rarely found in these days with any microscope, especially of American manufacture.

Artificial illumination may be used; even the somewhat dim coal oil lamp, which, however, requires inordinately long exposures. The acetylene gas light is altogether the best from an artificial source I have ever employed, and is quite satisfactory in time and quality. But altogether the best light for the purpose is diffused daylight from a window with northern exposure, than which nothing can possibly be better.

If, however, the camera is constructed so as to permit the use of the microscope in a vertical position, so much the better, as proper lighting of the object is more readily secured than when the instrument is inclined horizontally, an even illumination, avoiding deep shadows, giving the best results in most cases, and this is the more readily obtained when the object lies in a horizontal plane. Some objects are better shown under a diffused light, such as may be obtained near a window without the interposition of a condenser. If its color be dark or reflect but

little light, the bull's eye should be used focused upon the specimen, care being taken to avoid glare or excess of illumination which will result in a confused image in the negative. With some subjects the Lieberkuhn may be used advantageously, with others the parabolic reflector, but the majority yield better results under the most simple forms of illumination. A very little practice will enable the operator to determine this for himself, in widely differing cases.

The character of plates to be used for the negatives is probably of more importance than those for transparent objects. They should be of a good degree of sensitiveness but not too rapid, must be capable of giving great density if desired and should develop equally well with all mediums, so that the worker may employ that with which he is most familiar. The best and most satisfactory paper I have ever used is the "Velox," a modified bromide, capable of being handled by daylight but sensitive enough to be printed by lamp or gaslight, and giving black and white prints of the most exquisite and permanent qualities. "Glossy Velox" I have found to yield results superior to those obtainable on the matt surface. Some specimens are better delineated by allowing the light from the sky to fall as nearly perpendicular as possible upon them. Others again show better by throwing the light obliquely across their surfaces by means of the bull's eye condenser or parabolic reflector. They should always be carefully studied under various methods of illumination before making any attempt to photograph them, in order to determine upon the best resolution and definition of their several features. The light reflected from a white cloud and falling directly upon the object without the intervention of a condenser is best. Lighted from the same source, but with a condenser so arranged as to throw the light across their surfaces, causing light shadows gives good results.

The possibilities of this class of photo-micrography for real work or recreation only, are very great; the field boundless. I trust that others may feel inclined to enter upon it. A. M. S.

Micrometry of Human Red Blood Corpuscle.

FRANK JUDSON PARKER.

The commonly accepted average diameter of the red blood corpuscle of man is 1-3,200 in. or 7.9 microns, and although some observers have given smaller averages and some have reported larger measurements, no marked distinctions have been discovered between the corpuscles of different races or different nationalities. The cause of differences reported by various writers is attributed by Dr. M. C. White, to the different amounts of the corpuscle measured. Some rejecting all the dark border, others measuring one-half the dark border, while others include the whole of the dark border on both sides in their measurements.

Prof. Cabot, in his recent book on Human Blood, calls attention to a statement by Gram that "Measurements published by observers living in Southern Europe are smaller than those of Northern Europe, viz: Italians, 7 to 7.5 microns; Germans, 7.8 microns; Norwegians, 8.5."

To further investigate this question, I have made the measurements reported below. The measurements have been made using Bullock's microscope, with a $\frac{1}{4}$ inch objective made by Spencer and an Abbe condenser, Zentmayer's cobweb micrometer eye-piece and a stage micrometer by Leitz, ruled to 1-100 millimeter. This gave for each turn of the screw of the micrometer 6.85 microns, and as the screw head was graduated to 100 divisions, the micrometer is calculated to measure to 0.0685 microns or about 1-350,000 of an inch.

Each preparation of blood measured was placed upon a glass slide, dried and covered with thin glass.

Blood was measured from the following subjects, viz :
From F. J. Parker.....100 Corpuscles
Girl from Finland, age 25, 3 mos. in America. 500 "
Esquimeau girl, came with Peary.....500 "
American girl, age 17.....500 "
Italian boy, age 17, in America 3 mos....500 "

The blood of the Italian boy (7.99 microns) is a trifle larger than that of the American girl (7.90 microns); that of the girl from Finland, (7.89 microns), not as large as that of the Italian, whereas on Gram's theory it ought to be larger, and that of the Esquimeau girl (8.07 microns), though a trifle larger than any of the others, is not as large as Gram reports for the Norwegian, though coming from a higher latitude. The result of this investigation fails to show any marked distinction that could be attributed to difference of climate or nationality.

Occidental Sea Specimens.

ARTHUR M. EDWARDS, M. D.

I have infusorial earth from the following localities all containing diatoms and regard them all as from the Occidental Sea:

Lost Spring Ranch, Lake Co., Cal. From J. M. Meeker and F. M. Billings.
Between Lower Lake and Lake Port, Lake Co., Cal. From U. of Cal.
Central Nebraska. From Prof. C. E. Bessey.
Humbolt, Nev. and Pitt River, Cal. From J.S. Newberry.
Mendocino, Cal. From U. of Cal.
Salt Lake Desert, Utah. From A. A. Ade, Washington.
Little Truckee Bank, Winnemucca Lake, Nev.
Shasta County, Cal. From U. of Cal.
White Plains, Nev. " " "
Idaho, locality unknown. From G. Rust.
Beaver Lake Beds, Beaver Valley, Nev.

Upper Lake Beds, south shore of Mono Lake, Cal.
Truckee River, near Wadsworth, Nev.
Three miles south of Helen's Springs, Nev.
Truckee River, five miles west of Wadsworth, Nev.
Indian Reservation, banks of Truckee River, Nev.
Lake Bonneville, Utah.
Playo Beds in Canon south end of Carson's Lake.
Lake Beds exposed near L. Symonds Ranch, Mono Lake.
Walker River, with fossil bones, two miles south of Alder Creek Valley.
Hot Springs, Lower Lake beds, Rash creek, Mono Lake.
Four miles north of Wadsworth, White Terrace, Marble Butte, Nev.
White Terrace, Pyramid Lake, Nev.

White beds near First Point on north shore of Soda Lake.
From the Death Valley, Inyo county, California, infusorial earth has been sent containing Bacillariace. It came from a hill 500 feet from Owens river, and $\frac{1}{4}$ mile from Bishop P. O. It covers an extent of twenty acres. The fresh-water Occidental sea once covered that place, perhaps in Eocene time, and anterior to the strata of Monterey and of Richmond, Va. This earth has yielded among others:

Diatoma florenlosa in plants having immersed in it the following :

Amphora ovalis.
Cocconema lanceolata.
Cocconeis placentula.
Epithemia gibba, hyndmanni, sorex, and turgida.
Navicula foetida, and iridis.
Roicosphenia curvata.
Synedra capitata.

A grayish clay from F. A. Connelly, Bishop, Cal., also yields those forms in small quantity proving that the clay was beneath the infusorial stratum. When forming, clay settled all over the Occidental Sea having more and more

of the shells in it. The living forms in the lakes today are the descendants of those.

A Kettle-hole in Newark, N. J.

The marsh is about 4,050 feet long and 900 feet broad in the widest part. It narrows to a tongue which was about 450 feet wide in the south west extremity. It pointed due northeast, which was the way the ice in the glacier period came according to the opinions of most of the geologists that have studied it in New Jersey. When I visited the place, the temperature was 20° F. and the wind was blowing sharply, but I saw men had been digging a ditch through the marsh to lay a sewer. Subsequently, I found they had laid a sewer through 11th street where they cut through the marsh. The ditch was so deep that they had gone through five feet of marsh material with the red Newark sandstone below to the moraine. In the marsh material, which was mostly fine sand, there was at the bottom black peaty substance, the same as I got farther north. Where they had cut the sewer through was about one-third the distance down on the longitudinal of the marsh.

The sponge spicules were beautifully formed and plentiful showing that the water in the marsh was still and shallow, for sponges grown in plenty in such a piece of water. The *Bacillariaceæ* were of the usual kinds: *Navicula* or the *Pinnularia* type, but scarce. The bog or marsh was mostly made up of peat elastic and brown. The sand at the north-eastern extremity and the *Bacillaria* at the south-western extremity showing that they, being lightest, were carried to the south-western extremity, and the sand deposited at the south-eastern. It was a kettle-hole and pointed the way the ice came. Kettle-holes are not always filled with clay although they are commonly supposed to be so. I was very much disap-

pointed not to find Bacillaria in clay (Lacustrine sedimentary deposits) in a kettle-hole the first I visited for gathering diatoms. I reasoned that it was a kettle-hole on the edge of the glacial moraine and wondered why clay containing Bacillaria was not present. When I knew of the way kettle-holes on the borders of glacial moraines were made (by the clay on the surface of the ice and rushing down through a conical funnel-shaped hole to the moraine below), I then saw why it was they could be formed without clay in them also. The bottom of these kettle-holes are clear moraine stuff, but such kettle-holes are not common. One of these near here, by the village of Union, known as the old ship hole is 250 feet long, in the northwest, by 59 feet in the opposite direction. The bottom is clear glacial gravel without signs of clay anywhere. It is covered by trees down to the bottom. Near by is a well-marked kame pointing in the same direction. It is on the borders of a stream, the Elizabeth river, which has Bacillarian clay at the bottom. I cannot be sure that the Bacillarian clay is glacial or recent, but no clay is found near by which is glacial.

BIOLOGICAL NOTES.

L. H. PAMMEL.

The Compound Oospore of *Albugo bliti*.—In the Botanical Gazette for October (28:225) Mr. F. L. Stevens concludes his paper on the Development of the Compound Oospore of *Cystopus bliti*. The oogonium when cut off from the parent hypha contains about 300 nuclei, which enlarge and divide mitotically while the oosphere is being differentiated. "The oosphere is differentiated through a massing of the cytoplasm of the oogonium. By this process the nuclei, usually in stages of mitosis, together with the vacuoles, are expelled from the central region and there results a dense and coarsely vacuolate periplasm. This condition occurs when the antheridial tube is very short."

The antheridium contains at first about twenty-five nuclei which divide twice mitotically. The sexual nuclei differ in form; the sperm being elongated and the egg spherical. The antheridial tube penetrates slowly, by reaching the ooplasm at the time of zonation, later entering the oosphere and appearing as a conspicuously multinucleate structure. When it opens there are discharged about one hundred male nuclei which fuse with the female nuclei in pairs.

Holdfasts of Certain Florideæ.—Miss. C. M. Derick (Bot. Gazette 28:246) discusses in an interesting way the development of the holdfasts of certain Florideæ. She concludes that while the development of the different species and genera may show relationship, the chief interest lies in a biological reason for their appearance. A comparative study of the development of the spores and holdfasts shows that the variations are dependent upon the differences in light, temperature or the density of the surrounding medium and an adaptation of vegetative reproduction.

Vibrioids in the Plant Cell.—Lagerheim (Svenska Vet. Akad. Forh. 1899: No. 6), discusses the question of vibrioids in Ascoidea rubescens. Swingle discovered small cylindrical sharply differentiated bodies about the size of many bacilli in the cytoplasm of some Saprolegniaceæ and Florideæ. Vibrioids may be observed in the living cells. They show a slow undulating motion. Lagerheim states that these organs are best observed in the older hyphæ which are free from fat. In younger cells the fat and oil makes them indistinct. The number of vibrioids varies greatly. In older cells there are but few. In the Ascoidea the vibrioids are so much like bacilli that one thinks of them as living bacteria occurring in the cell. According to Lagerheim the best of the many staining fluids are triphenylmethane stains, especially fuchsine. Gentian violet, victoria blue and dahlia are most servicable. Ziehl's carbolic fuchsin is a most valuable stain, with this stain the vibrioids are colored deeply in a few minutes.

Indiana Plant Rusts.—Dr. J. C. Arthur has recently

distributed a paper on the Rusts of Indiana (Proc. Ind. Sci. 1898: 174). The list is made in accordance with the latest nomenclature, so that a good many names are changed. Some of the common genera like *Phragmidium* appear under the name of *Aregma*. In accordance with Kuntze's revision, *Uromyces* becomes *Cæomurus*, while *Puccinia* becomes *Diacæoma*. *Gymnosporangium* becomes *Puccinia*. The old *Puccinia graminis* and *Aecidium berberidi* becomes *Dicæoma poculiforme* (Jacq.) Kuntze, *Puccinia rubigo-vera* becomes *Dicæoma asperifolii* (Pers.) Kuntze. It is unfortunate that names which have been in use in some cases for nearly one hundred years should now be displaced. It is doubtful, however, if economic botanists will adopt these names since the old names are so well fixed, in connection with various diseases described.

Notes on Travel.—David G. Fairchild (Bot. Gazette 29: 122) of the U. S. Department of Agriculture is presenting some interesting biological observations on the general character of the vegetation of South American countries visited by the Barbour Lathrop Expedition. In a late number he discusses briefly the biological conditions of Venezuela. He says—"Venezuela landscapes show a larger proportion of Xerophytes than I had expected to see and a ten minutes tram ride to the small bathing place of Moquendo gave me a good opportunity of seeing the characteristic cactus vegetation of the coast."

Comparative Embryology of Rubiaceæ.—Francis E. Lloyd is undertaking a study of the Embryology of the Rubiaceæ a highly specialized and polymorphous family. This large order has been studied but little from an embryological standpoint. His studies will be awaited with interest. The first paper takes up *Vaillantia hispida*. "There can be little doubt that the rapid development of seeds is an important adaptive feature, and the study of structures which are correlated with this ability will be a fertile field for further study. Such haustorial structures as these found in Orchidaceæ may be correlated with the

meagre integument which means a meagre store of food immediately at hand."

MICROSCOPICAL SOCIETIES.

Washington.—On Tuesday evening, Nov. 21, officers were elected for 1899-1900: President, Prof. Paul Bartsch; Vice President, Dr. Rupert Norton; Recording secretary L. M. Moore; Treasurer, Dr. Robert Reyburn; Curator, W. H. Seaman. A paper was presented on "Medicine Droppers and Measurement of Drops." The society meets at 714 Thirteenth street on the second Tuesday of each month except in summer.

Royal Microscopical Society.—The President called attention to an old microscope made by Cary, presented to the Society by Mr. Gleadow, which was a very interesting addition to the Society's collection. An instrument of the same design was figured in the Journal for 1898, p. 474. Messrs. Watson and Sons exhibited their new School microscope, which was provided with a diagonal rack-and-pinion coarse adjustment, but no fine adjustment; their idea being to produce a strong well-made instrument at a low price. Dr. Dallinger had seen this instrument, and thought it would admirably answer the purpose for which it was intended; the coarse adjustment was so well made that he had no difficulty in focussing a $\frac{1}{8}$ in. objective with it. The President also thought the microscope was strongly made and well fitted, and would be found to be a very useful instrument. Messrs. Watson also exhibited a new form of eyepiece named the "Holoscopic" which was fitted with an adjustment to render it either over-or-under-corrected, and suitable for use with either achromatic or apochromatic objectives. Dr. Measures exhibited a microscope for photomicrography made by Zeiss, having a new form of fine adjustment which admitted of the arm being made of any length without throwing extra weight upon the fine-adjustment screw. Dr. Dallinger considered the way in which the speed of the fine adjustment had been reduced was

most ingenious ; the motion was extremely slow, being only 1-625 in. for every revolution of the screw. A protest had always been made in the Society against the fine adjustment having to carry much weight, and it was therefore satisfactory to find that this one had only one-fifth of the weight usually put upon the fine adjustment. The President said the application of an endless screw was a novel way of slowing down the fine adjustment. The reduction of weight upon the thread was an important improvement, and the increased length of arm was another good feature. The President then described a new form of fine adjustment by Reichert, which was shown applied to his "Austrian" model, exhibited by Mr. C. Baker. The indicator to this fine adjustment was movable so that it could be set to zero when required, thus greatly facilitating the reading of the divisions on the head of the screw. The instrument was fitted with the English standard substage, and the axis of the trunnions was placed upon the stage to insure a better balance. Two other microscopes by Reichert were also exhibited, one being a student's, without fine adjustment, but fitted with a dissecting loup as a substage condenser. The President next showed a microscope fitted with his new stepped rackwork coarse adjustment by Messers. Watson and Sons. There was no loss of time, though the pinion was pressed but lightly into the rack. The President also exhibited a dissecting stand by Andrew Ross, which was about 40 or 50 years old, and was still a thoroughly good working instrument, and though the lenses were not achromatic they gave very good images. Mr. C. Lees Curties exhibited some stereoscopic photo-micrographs taken on the Ives principle by Mr. E. R. Turner, who briefly described the method of taking them. Dr. Hebb said they had received Part VI. of Mr. Millett's reports on the Foraminifera of the Malay Archipelago, which would be taken as read and published in the Journal. Mr. F. Enock gave an extremely interesting account of his observations on the life-history and habits of the British trap-door spiders, illustrating the subject by most excellent original lantern views.

Quckett Club.—The 371st meeting was held on Friday, Oct. 20. Mr. R. T. Lewis presented a series of preparations of cattle ticks he had mounted from material sent by Mr. C. J. Pond, of New South Wales, and on which he made a communication at the April meeting. Mr. Curties exhibited a number of photo-micrographs of low-power objects with the Kromscope. Messrs. Watson exhibited their new educational or school microscope, with a well-made coarse, but no fine, adjustment, and their "Holoscopic" eyepieces with an adjustment to render them either under or over-corrected for use with achromatic or apochromatic objectives. Mr. Nelson was afraid that in inexperienced hands, at least, these eyepieces would introduce greater aberrations than those they were intended to correct, as it was a difficult and delicate matter to adjust an eyepiece to varying objects. Mr. Nelson made some remarks on a series of Reichert's microscopes shown in the room, with improvements in the fine and other adjustments. Also a new form of double-rack coarse movement, which he had devised to obviate loss of time or backlash in focussing, fitted for him by Messrs. Watson to one of their student's microscopes, and a fine adjustment to the substage of the same instrument. He considered this latter adjustment almost indispensable when immersion condensers of high aperture were employed. Mr. J. G. Waller read a paper on "An Undescribed British Sponge of the Genus *Raphiodesma* Bewerbank," illustrated by figures and by drawings.

NEW PUBLICATIONS.

Moulds, Mildews and Mushrooms.—This new book starts by showing the relations of fungi to other plants, adopting largely the general arrangement of Engler and Prantl. Underwood recognizes: I. Thallophyta, under which (a) algæ and (b) fungi are placed. II. Archegoniata, (a) the mosses and their allies, (b) ferns and their allies. III. Spermaphyta, the (a) Gymnospermæ, (b) Monocotyledoneæ, (c) Dicotyledoneæ. It is indeed gratifying that

the author lays stress on many fundamental facts in connection with the vital functions of fungi. He says, "the first character to be noted in all these plants, great or small, high in organization or simple in structure is the fact that they breathe." While facts like these are well enough taught in our colleges, too many teachers in our secondary schools do not lay enough emphasis on the fundamental principles underlying plant life. The writer briefly discusses the function, structure, reproduction, constituents and habits of fungi. Fungi are divided into three convenient classes. 1. Phycomyces (algo-fungi), 2. Ascomycetes (the sacspore fungi), 3. Basidiomycetes (the basidial spore fungi). The slime moulds Mecetozoa are regarded as co-ordinate with the phylum, Thallophyta. Bacteria with their evident close alliance to the blue green algæ Cyanophyceæ are regarded as forming together the group Schizophyta. Most of the orders of fungi are treated sufficiently complete to meet the requirements for a beginner. The matter is excellently arranged in every case. An interesting chapter on the study of mycology in general and its study in America in particular with reference to special works is a good feature of the work. Also a chapter on the geographical distribution of American fungi. The concluding chapter treats of the methods of collection and preservation of fungi, and hints for further study. Prof. Underwood's work should certainly be in the hands of every student of mycology.—L. H. P.

Botanizing.—Prof. W. W. Bailey of Brown University. 16 mo. 142 pp. \$75. This is a guide to collecting and preserving all kinds of botanical specimens including ferns, lichens, mosses, algæ, fungi and even fossils. Any intelligent boy or girl can, with this book, become a botanist or at least possess a collection. It is very full, explicit and plain with a dozen or more illustrations. It is small enough to carry on a tour in ones pocket. Nothing more or better for the purpose could be asked. In another column we will quote the directions regarding mosses.

MICROSCOPICAL NOTES.

To those public libraries not already subscribers to this journal, (though most of the large ones are already on our list), who send subscription for 1910 (\$1.50), we will make a present of THREE BOUND VOLUMES, 1895, 1896, 1897.

Card.—Qualitative, Quantitative and microscopical urinalyses, urinary calculi, gonococcus, urine for diagnosis of typhoid, sputum for bacillus tuberculosis, analysis of water, vinegar, milk, tests for arsenic in wallpaper, etc.—*W. H. Ohler, Portland, Me.*

Slides.—For the benefit of amateurs who find difficulty in obtaining good objects at a moderate rate, I offer first class slides, at cost price (3d. each). Material, lists, and information free. Dealers not supplied. Frank P. Smith, 15, Cloutesley Place, Islington, London, N.

Objects.—Foraminiferous sands, unmounted, 5 series of micro fungi at 50 cents each and 7 series of wood sections at 50 cents each series can be had from W. West, 15 Horton lane, Bradford, England.

How To Print Your Palm.—Burn a piece of gum camphor, accumulate the smoke on a piece of smooth, white, paper. Put the smoked paper flat on the table and hold your palm down firmly on it. Remove it carefully. Wet the clean side of the paper with turpentine and let it dry well. This holds the smoke on the paper and shows the print of all your lines if well done.

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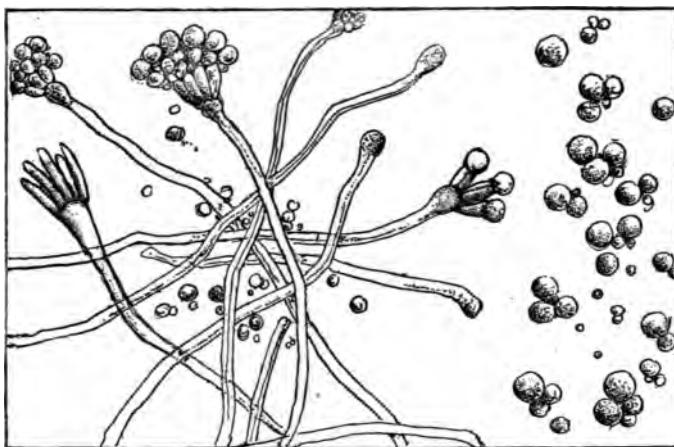


FIG. 1.—*ASPERGILLUS ORYZÆ.* (X 600).

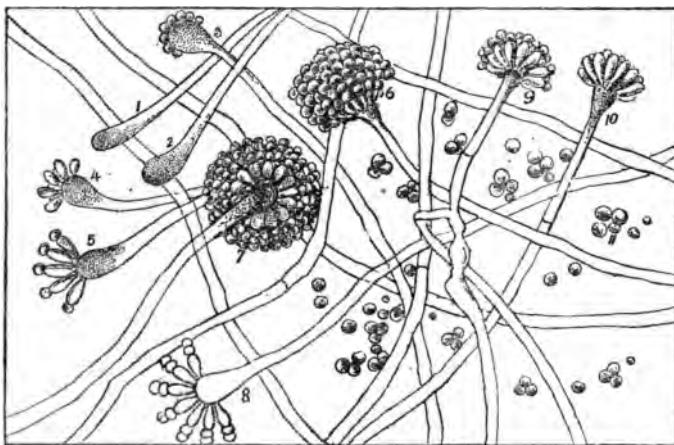


FIG. 2.—*ASPERGILLUS ORYZÆ.* (X 600).

Illustrating article on page 44.



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CONTENTS.

Cultivating Water Bacteria in Moist Atmosphere.....	33-39
An Interesting Object. Edwards	40-44
Aspergillus Oryzæ. Siebel, (With Frontispiece).....	44-45
Silicia Standards for Determination of Turbidity. Whipple.....	51-56
BIOLOGICAL NOTES.—Smuts; Turnip Rot; Wilt; Disease; Lactic Acid; Nitrification; Mineral Nutrients of Plants; Plant Hairs; Yellow Coloring Matter.....	45-48
MISCELLANEOUS NOTES.—Cooke. Cement; Water; Plasmodia; Fix Tentacles; Preservatives; Illumination; Fluid Mounts; Tumors.....	48-51
Scales. Soloid Stains; Tubercl Stains; Baker's No. 1 Instrument; Cement; Mounting Algæ; Micrometers; Nose-Pieces; Illumination.....	56-61
MICROSCOPICAL SOCIETIES.—Quekett; Royal	61-62
MICROSCOPICAL MANIPULATION.—Mosses.....	62

On the Necessity of Cultivating Water Bacteria in an Atmosphere Saturated With Moisture.

GEORGE C. WHIPPLE.

According to present practice the number of bacteria in a sample of water is found by mixing a certain quantity of the water with a certain quantity of sterilized nutrient gelatin and allowing the mixture to solidify in a Petri dish. After a longer or shorter period of incubation at a temperature at or about 20° C., the colonies that have developed upon the gelatin are counted, and from this count the number of bacteria present in the water is determined. Although this method is almost universally used, and although the results obtained are sometimes of

the greatest moment, there is such a lack of uniformity in the details of the process as ordinarily conducted, that the determinations of different observers are seldom comparable unless the methods of procedure are fully described. A standard method of procedure is urgently needed, but cannot be secured until the various factors that influence the result have been analyzed and their magnitude determined. In the course of a series of experiments conducted with this object in view, it was observed that the amount of moisture in the atmosphere of the incubator exercised an important influence upon the number of bacteria that developed. The results of these observations are summarized in this paper.

Before the use of the Petri dish it was customary to pour the mixed gelatin and water upon a cold glass plate, where it was allowed to spread out and harden. The plate was then covered with a bell-jar and put in the incubator. In order to prevent the gelatin from drying, moist filter paper was put at the bottom of the bell-jar. Thus the bacteria developed in a moist atmosphere. With the advent of the Petri dish the matter of moisture seems to have been lost sight of. This dish was provided with a tight fitting cover, and this was supposed to prevent evaporation from the gelatin. It is a fact, however, that the Petri dishes now on the market are not tight, and that often the covers fit the plates very badly. Furthermore, in laboratories where many dishes are in daily use, it is a common thing for dishes and covers to be mismatched, and often there is no attempt to mate them. The result is that an appreciable evaporation from the gelatin does take place, and that the amount of evaporation varies with different plates and different atmospheric conditions.

The effect which this uncontrolled factor exercises upon the development of bacteria is shown by the following experiments. Several series of cultures were submitted to varying conditions of moisture, with other conditions re-

maining constant. The plates were incubated in a moist chamber, in a closed chamber without moisture, in the incubator (or the ice chest), and in a desiccator. For the moist chamber a desiccator-jar was used, the sulphuric acid being replaced by water. The closed chamber was a desiccator-jar without sulphuric acid or water. The jars were large enough to hold five plates, and in all cases the figures representing the numbers of bacteria found were obtained from the averages of the five counts.

The largest numbers of bacteria were always obtained from the plates that developed in the moist chamber, and the smallest numbers were always obtained from the plates that were kept in the desiccator. If the number that developed in the moist atmosphere be assumed to represent the maximum number obtainable by the method, it follows that on 78 per cent of the bacteria developed in the desiccator, that 85 per cent developed in the closed chamber, and that the numbers that developed in the ordinary incubator and in the ice chest varied from 75 per cent to 98 per cent. There was a striking uniformity in the percentages which the numbers in the desiccator were of the numbers in the moist chamber and this was due, no doubt, to the constant atmospheric conditions in the two jars. In the closed chamber also the percentages were quite constant. In the ice chest and in the incubator the percentages were more variable. The atmosphere of the ice chest was ordinarily more moist than that of the incubator, but was seldom saturated on account of ventilation. The amount of moisture in the air of the incubator was generally greater than that of the atmosphere of the laboratory, and varied more or less with the ventilation, the number of plates kept in the incubator, etc. In one Series the relative humidity of the atmosphere in the incubator was estimated at about 60 per cent. In another Series the humidity was determined by hourly readings of a psychrometer and was found to vary be-

tween 65 per cent and 80 per cent, the average being 75 per cent. In a third series the atmosphere of the incubator was kept moist by means of jars of water, and the average humidity was 95 per cent. In a fourth Series the humidity was similarly kept at 98 per cent of saturation. The relation between the humidity and the development of bacteria is shown by the following comparison of the Series: Humidity, 60, 75, 95, 98 per cent while the number of bacteria that developed in the incubator was 75, 82, 98, or 97 per cent of the number that developed in the moist chamber.

The amount of evaporation from gelatin under the conditions described above was determined by weighing the dishes with their contents before and after incubation. It was found that in a saturated atmosphere the evaporation was inappreciable; in the closed chamber it was from 1 to 2 per cent of the weight of the mixed water and gelatin during 72 hours; in the ice chest it was about 3 per cent; in the incubator it was from 3 per cent to 5 per cent; and in the desiccator it was from 10 per cent to 15 per cent. The amount of evaporation varied greatly with different plates submitted to the same conditions.

This loss of water by evaporation is sufficient to cause important changes in the composition of the culture media during incubation, and this may be sufficient to affect the development of the bacteria, as these organisms are very susceptible to slight changes in environment. But the chief reason why increased evaporation is accompanied by a decrease in the percentage of bacteria that develop seems to be connected with the supply of oxygen. By successive weighing of the same plates it was found that the rate of evaporation was not constant, but decreased rapidly. For example, during the first hour of incubation the evaporation from a series of plates proceeded at the rate of .068 gram per hour; after 18 hours the rate of evaporation was .031 gram per hour; after 42 hours

it was .012 gram per hour, and after 96 hours it was .002 gram per hour. This retardation of the rate of evaporation appears to be due to a thickening of the gelatin at the surface. If such is the case, the thickened gelatin at the surface might materially reduce the supply of oxygen of the submerged bacteria and prevent the development of the less vigorous ærobic forms. Indeed, it was observed that the plates in the desiccator and in the moist chamber differed more in the number of submerged colonies than in the number of surface colonies.

These facts suggested the possibility that the Petri dish itself might serve to prevent the bacteria from getting a sufficient supply of oxygen. The experiment was made, therefore, of cultivating the bacteria in a Petri dish with the ordinary cover replaced by a ground glass top that made an absolutely air tight joint. A series of five cultivations made in this way gave the number of bacteria in a certain sample as 317 per cc., while a series of cultivations of the same water made in the usual manner gave 413 per cc. In the hermetically sealed dish, therefore, only 77 per cent of the bacteria developed. The air of these dishes was then collected over mercury, and the amount of oxygen determined by absorption with pyrogallic acid. It was found that the air of the ordinary dishes contained approximately 15 per cent of oxygen, while the air of the sealed dishes contained only 5 per cent. In other words, three-quarters of the original supply of oxygen in the sealed dishes had been used up by the bacteria during 72 hours, while one-quarter of the original supply had been used up in the ordinary dishes. It was found also that the air in the sealed dishes contained 5 per cent of carbon dioxide, while the air in the ordinary dishes contained but 2 per cent.

As a matter of interest a series of cultures was made in a jar filled with oxygen, and compared with cultures of the same water made in the incubator. It was found

that the average number of colonies that developed in the oxygen was 154 per cc., while in the incubator it was 137. The growth in oxygen also took place at a much more rapid rate.

Finally, one important fact was noted in connection with the cultures made in the jars that illustrates the important effect of oxygen. In all the jars the five Petri dishes were piled one on top of the other, and it was found that almost invariably the plate highest in the jar gave the largest count, and that the lowest plate gave the smallest count. This was particularly striking in the case of the jar filled with oxygen, where the upper plate contained 198 colonies per cc., while the lower plate contained 138. These differences between the upper and lower plates of the jars were greater than the differences observed between plates kept in the incubator. Liquefaction proceeded much more rapidly in the upper plates of the jars. These phenomena seemed to be due to an accumulation of carbon dioxide at the bottom of the jars, where either by its own properties or by exclusion of oxygen, it retarded the growth of the bacteria.

These facts tended to show that the supply of oxygen has a marked effect upon the growth of water bacteria on the gelatin plate, and that whatever tends to reduce the supply of oxygen, whether it be evaporation or an airtight Petri dish or lack of sufficient ventilation, will tend also to reduce the number of bacteria. The practical inference from this is that in order to obtain the greatest possible development of water bacteria on the gelatin plate, a ventilated dish should be used, and the cultures should be incubated in an atmosphere saturated with moisture.

It has been found that satisfactory ventilation of the Petri dishes may be obtained by grinding several small notches in the edge of the lower plate. If greater ventilation is required, it may be obtained by extending the

sides of the lower plate upwards at four points on the circumference so as to form pillars for supporting the cover, thereby allowing a complete circulation of air. It has been found that the bacteria counts obtained by using these ventilated dishes in an atmosphere saturated with moisture, compare closely with those obtained in open dishes protected from contamination and incubated in a saturated atmosphere, the results of one series of comparisons giving 97 and 95 bacteria per cc., respectively, by the two methods. Experiments have shown that there is no danger of these ventilated plates becoming contaminated from the air.

The cultivation of water bacteria in the moist atmosphere has the further advantage that the growths come to maturity in a shorter time. Liquefaction takes place earlier, but the growth of the deep-seated colonies seems to proceed at a still more rapid rate. A greater proportion of the plates are liquefied after 72 hours' growth, but on the other hand, the percentage increase between the 48-hour count and the 72-hour count is much reduced.

Incubators used for the cultivation of water bacteria should be well ventilated, and their atmosphere should be kept at or near the point of saturation. They should be provided with wet and dry bulb thermometers, and the relative humidity should not be allowed to fall below 95 per cent. Experience has shown that an atmosphere practically saturated with moisture may be easily maintained.

CLEAN AWAY BALSAM.—To remove an excess of balsam from around a cover-glass, allow the balsam to become hard and then chip it away with the edge of a blunt knife, taking care to avoid touching the cover-glass during the operation. A tooth brush dipped in methylated spirits will then readily remove what is left. Finally, dry and polish the slide with Japanese filter paper.

An Interesting Object.

ARTHUR M. EDWARDS, M. D.

Some years ago, in the midddle of September, I found in a swift running stream at Tylor Park Station on the Northern Railroad of New Jersey an organism that at the time was new to me and interested me much. I could find no published description of it, so I put it in the genus amœba for the time being. It was large, being about an inch across and did not require a magnifying glass to see its motions. Then I had not placed the Diatomaceæ in any kingdom but the vegetable: being convinced that they were plants and that plants and animals were distinct. Now I know that plants, Protista and animals are but stages of organisms and not distinct but only called so by those who know them imperfectly. On Sept. 15th, 1871, I went to Tylor Park station back of Hoboken, N. J. When searching up and down the stream I came across this giant amœba. Examining a portion by means of the microscope I drew my first illustration and made the following observation; it evidently belongs to the Protista of Haeckel but not to any of his genera. It was made up of granules which were moving about in the same way as the whole individual and it did not have an investing membrane which induced me to call it an amœba. The granules were shuttle-shaped and each trembled like the particles which escape from burst pollen, —the Brownian motion. I scraped some off of the stones on which I found it and did not hope to retain them alive, for the scraping by means of a knife was rough, but they did live and I saw it spread itself, for it was all united in one and seemingly branching itself out from a dark, opaque mass at the bottom, up the sides of the bottle. I disengaged it which I found easy to do by shaking the bottle, and transferred it to a zoophyte trough where it was made quite at home. It was very restless, continually spread-

ing out on both sides of the trough so that I was enabled to study it readily as a $\frac{1}{2}$ inch objective works through the glass side of the trough. I watched it spreading itself out. I saw a small fragmant, which was formless, not branched. Its granules were attempting, as I may say, to circulate like those of the large one for they were restless. After a while the larger one touched the smaller one and for a long time merely pressed against it and about two-thirds surrounded it. Then one and at last two points of union were formed, the granules of the small one mixed with those of the large one and the two became essentially one. I saw several clear ovoid beautifully blue masses without any investing membrane carried about in the current of granules. I tried to keep one of them in sight to see if it would change but could not do so. Afterward I found an ovoid mass which was apparently similar, partly blue and partly green, with granules in it. I watched this and saw it become more and more coarsely granular. The green larger granules increased in number and at length nearly filled up the ovoid mass thus replacing the blue granules, or the blue granules became green. Then it began to loose color and the granules at last became colorless. Then it began to move, rolling over this way and that very actively. At last it escaped from the Protista mass, by projecting part of it beyond the Protista mass and sailed off, apparently by means of cilia. On September 21, I again visited the stream where I got the Protista and found several very large ones, some covering a space from two to three inches square. I scraped off portions of one of the largest, put it into a bottle with water and in the evening it spread itself up the side. I also brought home a stone with a large one on it. Attached to the stones in the same stream I found larvæ of *Psaphenus lacontei*, also Polyzoan in plenty. The *Hydrodictyon* has spread down the stream and young are very plenty. Two days afterwards the

Polyzoan was alive in my tank and apparently doing well. The large Protista on the stone was also doing well and spread out finely on the upper side of the stone.

On the 24th of September, I made further notes. This morning on examining one of the very fine portions of the Protista, I found it to have playing around it, confined mostly to the broad expansions and outer margin, numerous oval active apparently ciliated animaleules. They are colorless and have numerous stomachs which are spherical. They are very active and seem to be feeding upon the Protista. I can find nothing to correspond with the active little fellows in the books. I found one inclosed in a mass of the Protista, so, if they were some of them feeding upon the Protista, he was punishing one of them for so doing. The oval creatures seemed to be encysted for there was a clear oval space around him which was always maintained distinct during the circulation of the Protista's granules. Inside of this endochrome the oval creature was very active, turning over and over, first this way and then that but seemingly not attempting to escape and not being digested. I thought this the mode in which perhaps the Protista took its food if it were omniverous. Such would seem to be the case, as it certainly fed on diatomaceæ. This, I have several times seen and it is shown by the diatoms passing up and down with its current of granules. The excreted empty silicious pustules it leaves behind on its journey show this also. It fed thus encysting it and constructing a temporary stomach for each new morsel. I continued to watch this particular case for nearly an hour. The vacuoles in the oval creature appeared greenish but this may have been due to refraction. After a while the Protista receded from the position it held. This retrograde movement was not accomplished after the same manner as the forward one. This is by a constant bulging out in all directions and the formation of lobulated expansions. Thereafter

they differentiate into current streams forming the meshes of reticulations seen in the larger branches and nearest to it. On the contrary the mode of recession was by attrition of the dark granular threads which did not snap but after a while seemed to give way from their adhesion to the glass and contract, as if they had been made of caoutchouc. At last the oval creature was near the periphery of the Protista when it seemed to project part of its mass outside of the Protista mass and, as if it had punctured a hole there, pushed itself through and crept out. Being now free it sailed off lively and was lost. In the afternoon I saw the Protista approach a small young branch of what looked like *œdогonium*, a fresh-water conferva, which had five Gomphonemas growing on it. The Protista surrounded it and I expected to see it encyst the whole mass, but it did not do so. On the contrary, it was a long time before I saw any action, when I saw the Gomphonemas drop off the larger plant and become carried away by the currents of the Protista granules. The *œdогonium* did not seem to be to the taste of the Protista for, during the time I watched it, it was not affected. The finding of these five Gomphonemas attached, in ordinary manner by their smaller ends, but without stipes, to the young *œdогonium*, which consisted of only two imperfectly formed cells which was growing upon the glass and therefore must have become attached there in the mobile form and grown before the Gomphonemas became fixed to it and since I put the water into this zoophyte trough raises the question as to how the Gomphonemas came there. Did they break off from some other alga, swim about and afterwards attach themselves to the *œdогonium*? I think it must have been so as I saw several of them scattered on the glass apparently not fixed but travelling on their valves or connecting membranes after the manner of *Naviculae*.

Since then I have suspected that this is a fungus be-

longing to the order of the myxomycetes. In the first stage of their life-history, the myxomycetes are mobile organisms, differing so strongly from any state of any vegetable that it was proposed by De Bary to place them among amœboid animal organisms. In this stage, where one would expect thallus of hyphæ, a mobile plasmodium is found, which in habit of life greatly resembles animal organisms. In appearance it is slimy or creamy, and consists of numerous anastomosing, net-like channels, through which there is conducted with more or less rapidity a current of protoplasmic matter containing many foreign bodies, such as particles of granules, diatoms, spores of fungi, etc. These channels are not bounded by any definite membrane, and the direction is frequently changed, probably for the purpose of gathering nourishment. Where one or more individuals are situated near each other, plasmodia occasionally unite. These mobile masses ultimately, usually after undergoing division, are transformed into motionless fruits.

Aspergillus Oryzæ.

J. E. SIEBEL, PH. D. DIRECTOR OF THE ZYMO TECHNIC INSTITUTE, CHICAGO.

With Frontispiece.

It is with much interest that I have perused the highly interesting and comprehensive researches relating to the Biology of "Aspergillus Oryzæ" by Mr. Golden in the December issue of this magazine, and in this connection I cannot forbear to call attention to some similar investigations which were published by me some nine years ago, and which evidently were not known to Mr. Golden.

The result of my investigations were published in the "Original Communications of the Zymotechnic Institute" Vol. 2 page 1 (issue of May 15, 1891) and from the accompanying drawing (Fig. 1) showing mycelium, conidia

and isolated spores in the earlier stages in the growth of fungus, taken from that article. It will be noticed that the morphological characteristics as established by me agree with those found by Mr. Golden in the main features.

One of the objects of my investigations was to establish a possible polymorphism in the life of this fungus which was suggested by the two different names "Eurotium Oryzæ" and "Aspergillus Oryzæ" under which the fungus went at the time.

Further observations published by me in the "Original Communications of Zymotechnic Institute" Vol. 2, page 65 (issue of October 18, 1892) in which I succeeded in obtaining plain preparations of the fully grown fungus, showing the Sporangia completely developed in every respect justify the appellation of "Aspergillus."

This is readily apparent from figure 2 taken from my later publication and which I think will be of additional interest as it completes the morphological biology of this fungus, which (although the industrial expectations attached to the same at one time may not have been realized) will always be a subject of great scientific interest, not only to the mycologist and microscopist but to the physiologist and chemist as well.

BIOLOGICAL NOTES.

L. H. PAMMEL.

NUCLEAR PHENOMENA IN SMUTS.—Harper (Trans. Wis. Acad. Sci. Arts & Lett. 12: 475-498 separate) finds that the nuclear phenomena in germinating *Ustilago scabiosa* are as follows: The promycelium pushes out without nuclear divisions having taken place in the spore. The nucleus wanders out of the spore and is to be found in the promycelium when it has reached one-third of the mature length. When the promycelium is mature the nucleus lies near its middle. When Flemming's triple stain is

used a sharply differentiated blue-stained chromatin net may be seen lying in a clear nuclear sap, a red stained nucleole, and a bounding membrane. The nucleus now divides, but the figure is too minute to study the process of spindle formation, the equatorial plate stage is distinct and shows a sharply bipolar spindle, whose fibres end in deep staining granules at the poles. Polar radiations were not observed at this stage. The chromosomes are densely massed at the equator and number probably eight or ten. The nucleole may frequently also be seen in the neighborhood of the spindle but reduced in size.

WHITE ROT OF THE TURNIP.—M. C. Potter (Univ. of Durham, Phil. Soc. 1899, separate) has described a new species of bacterium the *Pseudomonas destructans* on turnips which produces a white glazy appearance, the tissues are reduced to a soft pulpy condition. The bacterium secretes a cytase enzyme which in healthy living tissues dissolves the middle lamella and causes the swelling of the cell-wall. On agar-agar it produces a white glazy growth and rapidly liquefies gelatin, and during fermentation produces a large amount of carbon dioxide. Infection appears always to be introduced at a wound.

WILT DISEASE OF COTTON, WATERMELON AND COWPEA. Dr. Erwin F. Smith (Bull. Div. of Veg. Phys. and Path. 17 :) gives an excellent account of a wilt disease occurring on cotton, watermelon, and cowpea due to the *Neocosmospora vasinfecta* (Atk.) Smith with two varieties, one on cowpea and one on watermelon. It produces bright beautiful red perithecia in the ascomycetous stage. The conidial fruits are represented by the (1) microconidia or *cephalosporium* stage which are oval to narrowly elliptical nonseptate, the *Fusarium vasinfectum* and *F. niveum*. The (2) macroconidia or *Fusaria* stage with spores 3 to 5 septate, (3) chlamydospores; these are globose thin-walled, smooth and in mass are brick red. The fungus is an active parasite and destroys a great many plants by

first plugging the water ducts and afterward invading parenchymatic tissue. The results of Dr. Smith's work are not only interesting from the standpoint of vegetable pathology but show how important it is to follow out the life-history of many of our fungi by making careful cultures. Many of the species cannot be determined from the descriptions furnished by Saccardo and other writers. The work is accompanied by a large number of excellent figures.

LACTIC ACID BACTERIA.—Weigmann (*Centralbl. Bakt. u. Parasitenk. II Abt. 5: 859*) in his concluding article on an attempt at the classification of the lactic acid bacteria concludes that a large number of the so-called species are but forms of a single species. Many of these forms are described as cocci or short bacilli. It is difficult in many cases to be able to say whether such forms are cocci, or bacilli. It is difficult to separate on morphological grounds, but they are to be distinguished on a physiological basis. Diagnostic characters for the separation of species are to be found in such facts as the growth of colonies on the surface or down in the medium. Some species are very sensitive to the presence of oxygen. On this basis he divided the lactic acid bacteria into two groups.

NITRIFICATION.—Bailey (*Centralbl. Bakt. u. Parasitenk. II Abt. 5: 857*) considers it doubtful whether any organisms of nitrification are able to live entirely on mineral matter. He thinks the purity of mineral culture has been overstated; enough organic matter will get into the medium during the process of making to furnish matter for their growth.

MINERAL NUTRIENTS OF PLANTS.—Dr. Oscar Loew in a paper on the Physiological role of mineral nutrients (*Bull. U. S. Dept. of Agri. Div. of Veg. Phys. and Path 18:60*) gives an excellent summary on the important subject. In regard to calcium and magnesium he concludes

that calcium as well as magnesium salts are required for the formation of the nuclei and plastids, the calcium for the formation of calcium nucleo-proteids and the magnesium to make possible the assimilation of phosphoric acid. If lime salts are in great excess in a neutral medium, the formation of magnesium phosphate and consequently the assimilation of phosphoric acid will be retarded because the lime as the stronger base will withhold phosphoric acid when the soluble phosphate comes in contact with the lime salts. The excess of lime is the cause of an increased production of oxalic acid.

PLANT HAIRS.—In a recent classification of plant trichomes Hirsch Fuenfstueck (Beitr. z. Wiss. Bot. Abt. 4: 1899) places them under three heads as follows: basipetal, acropetal, and intercalary.

YELLOW COLORING MATTER WITH CHLOROPHYLL.—Mr. Schunck (Proc. Roy. Soc. 68; 177-186) finds in the alcoholic extract of chlorophyll of healthy green leaves, two yellow coloring matters along with the chlorophyll, the chrysophyll and xanthophyll. The latter is identical with the yellow coloring matter found in autumn leaves. Each of these colors has a characteristic absorption band.

Miscellaneous Notes on Microscopy.

JOHN. H. COOKE, F. L. S., F. G. S.

CEMENT.—A tough cement, suitable for use with the thinnest of rock-sections, may be made by heating together for some time sixteen parts by weight of Canada balsam and fifty parts of shellac.

WATER.—Distilled water should be used in the treatment of microscopic objects on all occasions, as on the evaporation of ordinary water, crystalline salts may be deposited on the object.

PLASMODIA.—Specimens of plasmodia, for the study of the myxomycetes, may be obtained from the scleratia which

is to be found attached to rotten wood or on the ground beneath old logs. To prepare these, Mr. M. Barber, of Kansas University, suggests that pieces of the material should be placed in a warm moist place. After a few hours the plasmodia will develop, and they may then be fed with rotten wood or fleshy fungi. Small plasmodia, for the demonstration of protoplasmic currents, may be obtained by putting pieces of sclerotia in a hanging drop of water, or by placing in a large cover-glass on a plasmodium and transferring it to a moist cell after the plasmodium has run over it.

FIXING TENTACLES.—Klienberg's picro-sulphuric acid is recommended for fixing zoophytes and polyzoa with their tentacles extended. The specimens should be placed in water, and as soon as they extend themselves they should quickly be covered with the solution. Fixation follows rapidly, when, after immersion in the usual grades of alcohol, they may be stained with any ordinary stain. Picro-carmine gives the most satisfactory results.

PRESERVATIVES.—Formalin is now largely used in most laboratories as a preservative and fixative re-agent. It does not interfere with processes of staining to any appreciable extent, nor does it cause much shrinkage of the structures operated on. Both as regards ease of manipulation and expense, it is decidedly superior to osmic acid.

ILLUMINATION.—A novel method of illumination, for the investigation of the structure of diatoms, is suggested by Mr. Allan Dick in his "Notes on the Polarizing Microscope." A thin platinum wire is twisted into a loop of just sufficient size to allow of the passage of a darning needle. This wire is rendered incandescent by a spirit lamp or a Bunsen burner, and it is placed at a distance of eight inches from a condenser in such a manner that the loop may be at right angles to the axis of the microscope tube. The most favorable condition for using this source of illumination is when the image of the loop may be

seen in the field of view just surrounding the object. In some cases it is better to use a triangular rather than a circular loop, so as to minimize the risk of mistaking circular effects.

FLUID MOUNTS.—To preserve for an indefinite period such fluid mounts as fish embryos, ova, and the like, it is necessary to use a cement having exceptional strength and fluid-resisting properties. The following cement is admirably adapted for this purpose. Take two parts of carbonate of lead, two parts of red oxide of lead, and three parts of litharge. Grind these very finely, mix them dry and keep in a wide-mouthed bottle. When required for use a little of the powder should be mixed with old gold size on a watch glass. It is necessary that there should be no trace of grit or unground matter in the mixture. A cell made with this cement may be filed off the glass slip without the cell breaking away.

TUMORS.—In a paper recently read before the Manchester Microscopical Society, Mr. J. V. Wolstenholme, F. R. M. S., gives details of the methods that were employed in his investigations on the micrococci (Botriomycetes), which produce the tumors in domesticated animals. He removed from the groin of a horse a pear-shaped tumor, the mass of which was dense, firm, and resistant, and of a pale pink color. In the centre was an abscess cavity, two and a half by one and a half inches, which communicated by narrow channels with a large sore or ulcer at the base of the tumor. For microscopical examination, portions of this tumor were hardened in (a) Muller's fluid, (b) picric acid, (c) alcohol, after which they were easily cut with the freezing microtome, and stained readily. In some cases it was found to be an advantage to embed the portion of tissue in celloidin before cutting. The stains used were (a) picro-carmine, (b) hæmatin followed by picro-carmine, (c) hæmatin, and then rubin and orange combined, (d) the Plantz method. Of these, the hæmatin with rubin and

orange gave the most perfect differentiation. The fibrous tissue was thus stained pink, and the nuclei purple. It was in the nuclei, which appeared as minute specks in a delicate fibrous growth, that the colonies appeared. Under the one-sixth objective a colony was seen to be made up of grape-like bodies, some of a pale orange, and others of a pale green color, but under the one-twelfth inch oil immersion the grape-like bodies were seen to be filled with cocci—small round elements—which were about 3 microns in diameter.—*Knowledge.*

Silica Standards for the Determination of Turbidity in Water.

GEORGE C. WHIPPLE, AND DANIEL D. JACKSON.

The subject of the turbidity of water is one that is growing in importance. This importance varies in different sections of the country. In New England, where the natural waters are comparatively clear, the terms "very slight," "slight," "distinct," and "decided," have been used by analysts to express the amount of suspended matter present. These degrees of turbidity have been estimated by the appearance of the examples to the eye when viewed toward the light. This mode of expression has been discarded by analysts who have had to deal with the problem of turbidity in connection with sand filtration or the mechanical treatment of waters that have large quantities of clay and other foreign matter in suspension. Experiments have shown that it is the finely divided suspended matter in water that is most difficult to remove by any system of purification, and it happens that these same fine particles have the greatest effect on the turbidity of the water. Hence, in questions relating to the filtration of water, the amount of coagulant required for clarification, etc., a reliable expression for the actual turbidity is more serviceable to the engineer than a knowl-

edge of the exact weight of the suspended matter. Consequently indefinite terms have been discarded and more accurate systems of numerical expression have come into use.

Of the various methods that have been suggested, only three have commended themselves to practical use; namely, the Wire Method, the Diaphanometer, and the use of Standards of Comparison. The first is a rapid method for obtaining approximate results, and serves well as a local standard and for the general purposes of field work, but it is not applicable to laboratory use. The second requires a somewhat elaborate apparatus and conditions of observation not readily obtainable in all laboratories. The third method is simple and quite satisfactory for general use. Standards of kaolin have been used for this purpose, but they are open to the objections that they cannot be readily duplicated and do not keep well when employed in connection with the color standard. These difficulties appear to be overcome by the use of finely powdered diatomaceous earth instead of kaolin. This earth may be obtained in almost any part of the country, and is prepared for use in the following manner:

The diatomaceous earth, as pure as may be obtained, is washed with water to free it from any soluble salts, and ignited to remove the organic matter. The perfectly white earth thus obtained is then treated with warm hydrochloric acid (1:1), after which it is washed with distilled water by successive decantations until free from the acid. The material, now composed of practically pure diatom frustules is then ground in an agate mortar to an impalpable powder and again shaken with distilled water. Any coarse particles that may be present are easily separated from the fine particles by sedimentation and decantation. The fine material is then allowed to settle, separated from the water, dried at 100° C., cooled in a desiccator, and placed in a stoppered bottle. The material

thus prepared for use consists of particles of silica that are about 1 micron (.001 mm.) in diameter, and that are fairly uniform in size.

A stock mixture is made by adding 0.5 gram of the prepared diatomaceous earth to 500 cc. of distilled water. This is put in a liter bottle in order to give room for violent agitation before measured portions of it are withdrawn. The mixture contains 1 gram of pure silica per liter, or 1,000 parts per million. This is absolutely unacted upon, either by distilled water or by the platinum-cobalt color standard, and when well shaken will always give the same turbidity.

For waters of low turbidities, standards are made up in gallon bottles. The stock mixture above described is called a standard of 1,000. Five standards are made from this by dilution, as follows:

Silica standard.	Number of cubic centimeters of stock mixture, to be made up to three liters with distilled water.
0, 5, 10, 15, 20	0, 15, 30, 45, 60

The numerical expressions given in the following table may be considered as the approximate equivalents of the terms now employed for expressing low turbidities.

Low turbidities observed in this manner are not appreciably interfered with by the color of the water, and consequently the color standards need not to be used in connection with the turbidity standards. But above a turbidity of twenty the water in the gallon bottles is too opaque to make satisfactory comparisons, and it becomes necessary to resort to the use of 100 cc. tubes. (Nessler jars about 20 mm. in diameter and 280 mm. long are preferable for this purpose, but the shorter form of 100 cc. Nessler tubes may be used). A series of twelve standards is made by diluting the stock mixture to the 100 cc. mark as follows:

Silicia standard.	Number of cubic centimeters of stock mixture, to be made up to 100 cc. with distilled water.
20	2.0
30	3.0
40	4.0
50	5.0
75	7.5
100	10.0
125	12.5
150	15.0
175	17.5
200	20.0
250	25.0
300	30.0

When the turbidites are low, the samples may be compared with the standards by holding both over sharp black lines on white paper, and looking through the tubes lengthwise. They may be compared also by examining them sidewise towards the light or over black lines, thus largely eliminating the effect of color. The higher standards are opaque when viewed lengthwise, and must be examined sidewise towards the light, or over black lines at an angle with the light. During the comparison of the

water with the standards, the tubes must be shaken occasionally in order to keep all the material in suspension. The stoppers used in the tubes should be boiled in water before they are used, in order to extract any natural coloring matter which they may contain. Waters that have both a high color and a high turbidity may be compared with standards made by combining the silica standards with the platinum-cobalt color standards. The color of the water is first determined by filtering the sample, and the turbidity then observed by comparing the original water with silica standards made to have the same or nearly the same color.

The various river waters recently examined have shown turbidity-readings up to 3,000 of the silica standard, and some of them have had also a high color. It was found that the turbidity of these waters could be accurately determined by dilution of the samples to bring them within the range of the series above described. In most cases this dilution with distilled water entirely eliminated the effect of color. It is only in cases of especially high color and where great accuracy is required that it will be necessary to use the combined color and turbidity standards. In those cases where the suspended particles themselves are colored, sufficient dilution will overcome the difficulty.

The relative value of silica and kaolin for turbidity standards is shown by the following comparisons: Three samples of kaolin were obtained from different sources and standards made from each by adding equal weights of the material prepared by elutriation, to the same volume of water.

	Turbidity.
Silicia	100
First sample of kaolin	125
Second sample of kaolin	135
Third sample of kaolin	220

The resulting turbidities were far from uniform, as is

shown by the comparisons with the silica standard.

Different preparations of silica from diatomaceous earth on the other hand, gave practically uniform results. Microscopical examination of the silica and kaolins showed that the particles of silica obtained by grinding the diatomaceous earth were quite uniform in size, while the particles of aluminum silicate showed much greater variations. In some of the samples the kaolin particles were much finer than in others, which accounted for the great variations in turbidity in different samples of kaolin.

The silica method of determining turbidity has been employed with a large number of waters, in which nearly every form of turbidity has been represented, and as a general laboratory method it commends itself for simplicity, uniformity, and accuracy.

MT. PROSPECT LABORATORY,
Brooklyn, N. Y.

Notes on Microscopy.

F. SHILLINGTON SCALES, F.R.M.S.

“Soloid” Microscopic Stains.—The tendency of solutions of the aniline dyes to decompose is well known, and has been a fruitful source of trouble to microscopists. Messrs. Burroughs, Welcome and Company, London, obviate this danger by supplying certain stains not only in a dry state, but in tabloid form, each tabloid, or, as the makers call it, “Soloid,” being of known strength and requiring only to be dissolved in water or alcohol to produce a solution of equally definite concentration. The stains at present sold are Eosin, Bismarck brown, Fuchsine, gentian violet, and Methylene Blue. Each “Soloid” contains one grain, and can be obtained from the microscopical opticians in tubes of six “Soloids” for the modest price of sixpence. The instructions given with the stains are so clear and practical that we cannot do better than reproduce one or two examples. A saturated watery solution of fuchsine, methylene



blue, gentian violet, or Bismarck brown is obtained by powdering one "Soloid" stain in 7 c.c. (two drachms) of distilled water, and then well shaking. Five to ten per cent dilutions with distilled water of these saturated solutions are well adapted for ordinary staining purposes. Thus one drachm of saturated solution made up to two ounces with distilled water gives 1 in 17, or a 6 per cent solution. A saturated alcoholic solution of methylene blue, gentian violet, or Bismarck brown may be obtained by heating in the same way one "Soloid" stain with a similar quantity of absolute alcohol instead of distilled water. A saturated alcohol solution of fuchsine is obtained by heating two "Soloids" with 3·5 c. c. (one drachm) of absolute alcohol. A solution of eosin suitable for general staining is obtained by dissolving one "Soloid" in 12·25 c. c. (three drams) of 50 per cent absolute alcohol in distilled water. This gives approximately a 0·5 per cent solution. Loeffler's alkaline methylene blue, aniline gentian violet, etc., can be readily made as wanted in the same simple and systematic way.

To Stain the Tubercl Bacillus.—Transfer a small quantity of sputum, containing, if possible, one or more of the small yellowish masses, to a glass slide; cover this with a second slide and rub the two together until the sputum is thoroughly broken up and mixed. Draw one side of a clean cover slip across one of the slides so as to cause a thin film to adhere to it; allow it to dry in the air, and fix by passing, with the film upwards, three times through the flame of a spirit lamp or Bunsen burner. Now place the cover slip film upwards, and with an edge projecting, on the end of a strip of metal about half-an-inch wide and eight to ten inches long, and carefully drop the carbol fuchsine solution upon the film so as to cover it without running over on to the metal. Place the metal in the flame at such a distance from the cover slip that the stain just steams gently; carefully avoid boiling, and after two minutes remove the slip with forceps. Drain off the surplus stain on to blotting paper, wash well under a tap or in a large beaker of water and place for 10 seconds in 25 per cent hydrochloric acid.

Wash well in methylated alcohol until no more red color comes away; rinse in water, and, still holding the cover slip with the forceps, drop a watery solution of methylene blue upon the film and allow it to stain for thirty seconds. Drain off the stain, wash rapidly in water; press gently between folds of blotting paper, and allow it to dry in the warm air above the flame at such a height that the hand can be easily held there. Mount in xylol balsam. Tuber-cle bacilli will be stained red by the fuchsine; all other organisms will be colored blue. A very convenient and useful method for the preliminary staining and examination of any smear preparation, is to mount it, when fixed, in a drop of Loeffler's methylene blue and remove all surplus stain by gently pressing a piece of blotting paper upon the specimen. Microbes, cell nuclei, etc., take up the dye very readily, and show up well although mounted in the dye itself, which in such a thin film appears almost white by contrast.

Baker's Number One, D. P. H. Microscope.—Mr. Chas. Baker, London, has adopted the lever form of fine adjustment, which, originally so adversely criticised, has now justified its existence as being one of the most delicate, yet steady and reliable adjustments made. The form of tripod foot is steady and gives more room than usual for the adjustment of the under stage arrangements. The microscope is fitted with the usual focussing and centering sub-stage, swinging tail-rod of mirrors, draw-tube, etc., and with addition of the excellent mechanical stage costs \$53.25. Without this last, but with the Nelson type of horse-shoe stage, fitted with sliding bar, the microscope costs \$42.00. This instrument can be strongly recommended both for workmanship and design, for all purposes of original research.

Cement for Glycerine Mounts.—In making permanent specimens of objects mounted in glycerine or Farrant's medium, considerable difficulty is experienced in cementing the cell. I have tried various methods, but the most successful in my hands has been to use a thick solution of



gum dammar in benzole. Select a clean sample of the gum and dissolve in benzole until the required consistency is reached. The edge of the cover-glass is then freed from superfluous mountant, and the cement laid on in the usual way. The first layer will in a few hours be sufficiently set for the application of a second, which is generally necessary.

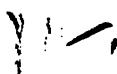
Mounting Algæ.—Boil some water for ten minutes to get rid of the air in it, and in this gently heat or even boil the specimen itself, for an other twelve or fifteen minutes, and finally put the latter under the air pump in a very small quantity of the same water. Before mounting in glycerine jelly, soak in a mixture of glycerine and water, and examine under a dissecting lens. If any air-bubbles should still remain in the cells they must be removed carefully one by one with a fine needle. It is useless putting the slide under the air-pump when mounted—glycerine jelly sets and cools too quickly, and is besides too dense to displace the air in the cells. The object needs the above careful preparation beforehand. Glycerine jelly is always more troublesome than Canada balsam with respect to air bubbles, but is otherwise very suitable for botanical mounting. There is no book which will enable one to identify algæ off-hand, without a preliminary study of the subject, but I would suggest obtaining "Gray's British Seaweeds" or Harvey's "Manual of British Marine Algæ." The authoritative book on Marine Algæ is Harvey's "Phycologia Britannica," but it is very costly (\$37). M. C. Cooke's "British Freshwater Algæ" is the best book on the sister subject.

Micrometers.—Some method of measuring objects will be required, and the simplest means of doing this is to become possessed of a stage micrometer, which is a slide 3 in. by 1 in. ruled in 1-100ths and 1-1000ths of an inch, or 1-10ths and 1-100ths of a millimetre, and costing \$1. A small disc drops into the Huygenian eyepiece, and lies on the diaphragm. This is called the eyepiece micrometer, and it is also ruled with divisions that generally bear some relation to an inch or millimetre scale. This also costs \$1.25. To

make measurements it is only necessary to note the number of arbitrary divisions in the eyepiece micrometer corresponding with the object to be measured, and then to replace this object on the stage by the stage micrometer, and note the exact measurements which correspond to those taken in the eyepiece. There are other forms of micrometer, but the above is simple and inexpensive, and quite satisfactory for most purposes.

Nose-Pieces.—These are a great convenience, but scarcely a necessity. One or two opticians have latterly so arranged their objectives that they are all nearly in focus when rotated on the nose-piece. Under any circumstances however, do not use a triple nose-piece, to say nothing of a quadruple one, as the weight of three objectives is quite sufficient to put a severe strain upon the fine adjustment. The cost of a double nose-piece varies from \$2.75 upwards. The cheapest nose-piece and perhaps the easiest to use, is the one known as "Beale's Neutral Tint Reflector." It is simply a disc of tinted glass placed above the eyepiece and at an angle of 45 degs. to the optic axis. To use it, however, the microscope should be placed in the horizontal position, which is not always possible. The eye is placed above the disc of glass, and looking down through it on the drawing paper placed immediately beneath, the microscopical image can then be readily traced.

Illumination.—This is easily done if two lamps are used, one for the microscope as usual, and one to illuminate the paper. A little adjustment of the light in each lamp will then be all that is necessary. The lamp itself should be paraffin with a $\frac{1}{2}$ in. wick. A cardboard screen can easily be made to go round it. The excellent and often elaborately fitted lamps sold by opticians are, of course, very convenient, but are only absolutely necessary for those who do much work. Their great convenience is in the readiness with which they may be raised or lowered, and the flat receptacle for the oil, that enables them to be brought close to the table. If a regular microscope lamp be bought it should certainly be of this form, and capable of rotation,



so as to enable either the flat or the edge of the flame to be used, and it should have an iron chimney holding an ordinary 3 in. glass slide, to be readily and cheaply changed if cracked. Such a lamp would cost about \$6. A reflector is worse than useless, as it confuses the light rays.—*Sci-Gos.*

MICROSCOPICAL SOCIETIES.

Quekett Club.—The 372nd meeting on Friday, Nov. 17th. Dr. J. Tatham, M. A., President, in the chair. A series of photographic reproductions of the plates in Ehrenberg's "Radiolaria from Barbados," published many years ago as a supplement to the "Mikrogeologie," and now scarce, was presented by Mr. Mottram. Messrs. Baker exhibited Leitz's new travelling or portable microscope, with folding base and removable stage, coarse adjustment by rack, fine adjustment on the Roberval plan, Abbe condenser and Iris. Mr. A. Earland read an elaborate paper on the "Radiolaria or Polycystina," dealing with their classification, morphology, physiology, and distribution.

Royal Society.—At the meeting on Nov. 15, Dr. Hebb called attention to the Volume of the Transactions of the Jenner Institute of Preventive Medicine, which he thought would be of great interest to those engaged in bacteriological work. Mr. C. L. Curties exhibited a new form of portable microscope by Leitz. It had a folding foot and a removable stage, to enable the instrument to be packed in a small compass. The body was not made to incline, but was furnished with a coarse and fine adjustment, and the stage was fitted with a modified form of Abbe condenser with Iris diaphragm. The President thought the instrument would be useful to those requiring a very portable one; its great compactness was effected in an ingenious manner, while the working parts were well made and finished. The President read a short note descriptive of a set of three simple hand-microscopes, on the Coddington principle, sent for exhibition by Mr. Edward Swan. They were apparently made for a medical man, and could not be very old.

Dr. Hebb said Prof. Groves had made some modification in a form of hand-microtome, and had sent it for exhibition. The President called attention to six photomicrographs of the larvæ of gnats, taken from life, by Mr. J. T. Holder. The President exhibited an old Gillett condenser, dated July 20, 1849, which had a collar adjustment. Dr. H. C. Sorby's paper, "On the Preparation of Marine Worms as Microscopical Objects," was read. The subject was illustrated by beautifully-mounted slides exhibited under microscopes. The attention of the meeting was then directed to a fine exhibition of Foraminifera, by Mr. Earland, shown under a large number of microscopes, with descriptions explaining the points of interest in each slide.

MICROSCOPICAL MANIPULATION.

Mosses.—Every bryological student should cultivate the habit of preserving microscopic mounts of the characteristic portions of the mosses which have been studied. A collection of this sort is an invaluable adjunct to the herbarium, and these mounts are constantly being referred to in subsequent studies of the same or nearly related species. A mica mount has a great advantage over the glass for this purpose, as it can be kept in a small envelope fastened to the herbarium sheet with the dried plant, and is thus all ways easily consulted and can readily be sent through the mail. The mica slide should be fairly stiff and about two inches by seven-eighths of an inch. The mica cover should be thinner than the slide and of generous proportions, as compared with the ordinary glass cover. Glycerine-jelly is generally used as the mounting medium, and the method of procedure is essentially the same as in making glass microscopic mounts.

It is seldom necessary to use an extremely high power objective in studying the mosses, so that the objection offered by some microscopists to the use of mica slides (*viz.*, that modern objectives have been adapted to a certain thickness of cover glass and any change in that thickness or substance affects the image) is seldom if ever realized.

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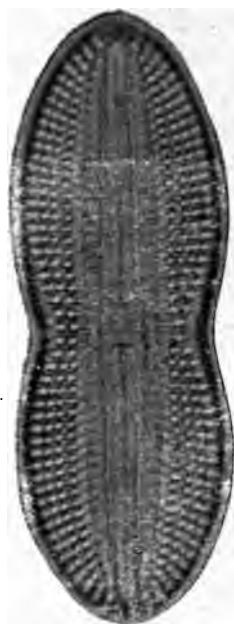
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CONTENTS.

The Examination of Mounted Sections of Drugs	63-69
NOTES.—By F. Shillington Scales; Steel; Objective Changer; Histologist's Microscope; Illumination; Dissecting	69-75
BIOLOGICAL NOTES.—A Soil Organism; Influence of Pure Metal on Plants; Texas Cattle Fever; Penicillium Glaucum and Pellagra; Dwarfing Alpine Plants; Lake Flora	75-79
NOTES.—By J. H. Cooke; Carbolic acid; Cement; Diatomites; Crystals; Insects; Objectives; A Tele-microscope; Standards; Fungi; Air-bubbles	79-82
Report of the Postal Micro. Club. R. H. Ward	83-86
NOTES ON SLIDES.—Trichinosis; Dermoid Cyst; Sphaerozoum Punctatum; Midrib of leaf of Strelitzia; Deposits in Steam Boilers	86-89
MICROSCOPICAL SOCIETIES.—St. Louis Academy	90
MICROSCOPICAL APPARATUS.—Photo-micrographic	90-91
MISCELLANEOUS NOTES.—Habits of Melicerta	91-92

The Examination of Mounted Sections of Drugs.

WILLIAM KIRBY.

The study of microscopy is becoming of increasing importance to the pharmaceutical student in the department of *materia medica*. There is no need in this place to emphasize its importance beyond saying that with each change made by the Board of Examiners in the subjects of examination, microscopy occupies a more prominent position. No doubt the best plan to adopt in the anatomical and histological study of drugs is for the student to prepare the material and put up his own mounted specimens; but there are many who are unable to devote the time to so long a course, and they are, in consequence,



obliged to work over a few drugs, and for the rest have to be content to acquaint themselves with the microscopic characters as exhibited in drawings and mounted specimens. Drawings are always more or less diagrammatic. They should not be relied upon by the student for the recognition of microscopical preparations of drugs. To the expert a drawing may be of value, but the student should look upon it simply as a key to assist in identifying the tissues and cells in an actual specimen. Mounted sections are, therefore, greatly to be preferred; but the temptation to indulge in so-called "spotting" should be strictly avoided, because of the numerous pitfalls into which the "spotter" may fall. Anyone trusting for the recognition of a section to the tout ensemble may be easily misled by differences between stained and unstained material, cleared and uncleared specimens, glycerin, glycerin jelly, and balsam mounting media, as well as by variations in the size and age of the plant from which the sections have been cut. For the most part the cursory examination which many students vouchsafe to specimens of this class is quite unproductive of knowledge, and in some cases may lead to positive confusion. It is clear that only a systematic examination of every specimen can be of any real value, and it seems desirable to indicate some lines upon which such an examination may be undertaken.

The characters to which attention should be directed fall into two categories, namely, those inherent in the mounted specimen, and those resulting from the methods of preparation. Dealing with the latter first, the variations due to mounting media, stains, and methods of clearing should be noted.

MOUNTING MEDIA.—Those most generally used are Canada balsam and glycerin jelly; more rarely used are glycerin, dammar, carbolized water, and, still more rarely, solutions of potassium acetate and calcium chloride. Sections of plant structures put up in glycerin jelly, glyce-

rin, carbolized water, and solutions of the salts mentioned exhibit the cell walls more nearly in their natural conditions as to thickness than do those mounted in the resins; the contours of the cells and of the cell contents, starch, crystals, etc., are also much more clearly defined; but the field of view is darker and the tissue systems are not so well differentiated as in Canada balsam. Generally only stained material is mounted in Canada balsam, and the colored cell walls stand out with great clearness, while the unstained cell contents are to a great extent suppressed from the field of vision. The various kinds of tissue may be readily distinguished, but the characters of the cells are not so evident because of the dehydrating process to which the material has been submitted, the cellulose walls being thin and often wavy. Starch is occasionally mounted in balsam for the purpose of examining it with polarized light, but the medium is a most unsuitable one for exhibiting the general characteristics of starch.

STAINS.—Sections are generally stained with two colors, green and red being the favorite ones. If the cell contents have been removed it will not be difficult in such slides to distinguish between the lignified tissues, which are stained green, and the cellulose tissues, stained red. Carmine and hæmatoxylin are the stains usually used for cellulose. The former of these, when used as a general stain, does not attack the lignified tissues, but the latter does so to a varying extent, so that in the absence of a counter-stain, the distinction between cellulose and lignified tissue is not at all clearly marked. Indeed, the intensity of color diminishes in proportion to the extent to which the lignification has taken place. Therefore the student cannot rely upon hæmatoxylin as a means of separating lignified from non-lignified tissues. In connection with hæmatoxylin and carmine it should be remembered that the section may have been cut from fresh ma-

terial, in which case cells with protoplasmic contents will exhibit stained nuclei. In sections stained with Hanestein's violet the cellulose will be found to be violet, and the different kinds of lignified tissue will exhibit different shades of red. Some sections may have stained cell contents; proteids may be colored red with borax carmine; starch may be colored pink with safranin or corallin; the callose of sieve tubes may be stained pink with corallin or steel-blue with aniline blue. Sufficient has been said to indicate that stains cannot be relied upon solely to differentiate between the various elements in a specimen; they do, however, assist in differentiation being accomplished with greater clearness and certainty.

CLEARING.—The student should be careful to observe whether the cell contents have been removed by clearing, as the difference between a cleared and non-cleared slide is so great as to mislead a casual observer.

SKETCHES.—How can the inherent characters of the specimen best be apprehended? By observing the various tissues in a regular order, and transferring the observations to paper in the form of a sketch. The value of the observations will be greatly increased if the sketch is afterwards compared either with a published drawing or description. The characters to be noted will, of course, differ, according to the nature of the specimen; but an outline applicable to a few general cases may be useful.

STEMS, ROOTS, RHIZOMES.—Beginning with the periphery in plants in which secondary growth has not begun, the epidermis and its appendages would be noted; but in drugs, if of the dicotyledonous type, the thickness of the cork would be recorded. Then the primary cortex; the extention and comparative size of its cells; the presence and location of collenchymatous tissue; the presence and location of sclerenchyma, and whether in groups or a continuous ring, and if in groups, their frequency and form; also, if accompanied or otherwise with calcium oxalate

crystals; the nature of the cell contents in the different parts of the primary cortex. In the secondary cortex, including the phloem, should be observed:—Its width, the width of the phloem rays; the frequency, width, and direction of the medullary rays; the presence and location of bast fibres; the presence and location of other sclerotic elements in the phloem; the presence of sieve elements, and the proportion and arrangement of phloem parenchyma accompanying them; the presence and location of laticiferous vessels; the nature and quantity of cell contents, particularly the presence of crystals and their form and size. After the cambium would be noticed the xylem; the kind and proportion of xylem fibers; the size, proportion, kind, and arrangement of the vessels when present; the presence of wood parenchyma, its proportion and distribution; the presence of specialized cells, with their contents; the medullary rays, their frequency, width, and contents. When vessels are absent from the xylem particular care should be taken to notice whether the xylem is composed of fibers only, or whether tracheids are present, and to what extent; also the character of the fibers should be determined. This, of course, can only be accomplished by the examination of longitudinal sections. If a pith is present the character and contents of its cells should be noted, as well as the presence or absence of phloem strands, indicating bicollateral bundles. The foregoing sketch refers more particularly to structures in which a more or less concentric arrangement of the tissue systems prevails. Any eccentric arrangement of the tissues should be particularly recorded. If the fibro-vascular elements are scattered it should at once be ascertained whether the section is dicotyledonous or monocotyledonous, or whether it belongs to the Pteridophyta. In the case of monocotyledons the outer integument should be observed; the presence or absence of fibro-vascular bundles in the cortex, their frequency, if present,

especially as compared with the frequency of the bundles in the central cylinder; the endodermis, whether homogeneous or heterogeneous, the shape and thickening of its cells; the frequency and arrangement of the fibro-vascular bundles of the central cylinder, the relation of the phloem and xylem to each other; the cells of the fundamental tissue and their contents, and the presence or absence in it of intercellular space. In the Pteridophyta, in addition to characters which are indicated by what has already been said, attention should be directed to the characters of the endodermis and the pericycle. The limits of an article do not permit of all the various details of microscopical analysis being dealt with fully, so it will perhaps suffice to mention one or two other classes of slides, and the method of examination to which they should be subjected. Leaf sections should be examined with a view to observing if the leaf is of the bi-facial or centric type; the epidermis of the upper and lower surfaces should be compared, the size, form, and thickening of the individual cells being noted, the presence of hairs, glands, and stomata, as well as the size and other characters of the same should be observed. Attention should be directed to the palissade cells, if present, their form and location; to the remaining parenchyma of the mesophyll, whether closely or loosely compacted, and the nature of its contents. The presence of hypoderma should be particularly recorded, as should also the presence, location, and characters of other sclerotic cells. Crystals and specialized receptacles, such as oleo-resin and tannin sacs, should be noted. The fibro-vascular system must be examined to ascertain whether it is restricted to a central strand only, or is accompanied by lateral ones. In connection with this system should be observed the relation to each other of the phloem and xylem, and the presence of stereom in the form of a continuous or discontinuous sheath. As a type of other classes of slides, starch

may be taken. In this case observations should be made of the form, size, position, and character of the hilum, and the presence, frequency, and direction of the striae. It is only by a systematic survey of the characters of each slide upon similar lines to those laid down that the student can hope to obtain from mounted specimens an intelligent apprehension of the anatomical and histological features of vegetable drugs.—*Pharm. Journal.*

Notes on Microscopy.

F. SHILLINGTON SCALES, F.R.M.S.

MICROSCOPICAL EXAMINATION OF STEEL.—The Microscopical examination of steel and of alloys in engineering laboratories is no new thing, but its value and utility in the steel industries were brought by Mr. C. H. Ridsdale prominently before the members of the Iron and Steel Institute at their autumn meeting. Mr. Ridsdale gave some of the results of his study of soft steel up to the present time, and explained how he had systematised its microscopic study, and adapted it to the commercial as well as the scientific requirements of a laboratory where commercial interests predominated. In the interesting discussion that followed, stress was laid upon the importance of formulating a method of procedure, by means of which uniformity of results might always be obtained. Prof. Porter, of Montreal, stated that he was engaged in equipping an expensive micro-laboratory in his college at Montreal, and remarked that the importance of the subject was fully recognized both in Canada and the U. S.

NEW OBJECTIVE CHANGER.—An objective changer has recently been produced. It is both inexpensive and effective, and is less cumbrous than that of Zeiss. Into the end of the microscope tube fits a screwed ring provided with a semi-circular jaw beneath, the jaw itself lying immediately beneath the ring and being kept against it by a spring

between two projecting arms. Accordingly on compressing the arms the jaw leaves a space of about a quarter of an inch between it and the above ring. Each objective is fitted with another steel ring only a little larger in diameter than the milled head of the objective. The objective, instead of being screwed into place as usual, is then simply slipped into position beneath the body tube of the microscope, and is there securely gripped by the semi-circular jaw. As the ring on the objective is made to fit accurately into a recess in the ring that is screwed into the body tube, the objective itself is well centred, though it might possibly be not quite satisfactory for the highest powers. Those who prefer this type of objective changer to the ordinary rotating nose-piece will find this simple little device useful. It is made by R. Fuess, Steglitz, near Berlin. Its price, with four adapters, is only \$4.00.

CROUCH'S "HISTOLOGIST" MICROSCOPE.—Mr. H. Crouch, of 22 Duncombe Road, London, N., has submitted the latest model of his "Histologist" microscope, which is specially designed for the use of students, particularly medical students. The coarse adjustment is by the now customary diagonal rack and pinion, and the fine adjustment is of the micrometer screw type. The foot is a claw-tripod, and as such is perfectly steady. The stage is of the horseshoe pattern, but in the microscope submitted to us the advantage of this was somewhat discounted by the sub-stage ring being fixed in position beneath the stage. The microscope itself is well made and finished, and is specially designed to withstand the rough wear and tear of a laboratory. There are the usual plane and concave mirrors. The objectives generally supplied are the $\frac{1}{2}$ -inch, N. A. .28, and $\frac{1}{4}$ -inch, N. A. .65, both being arranged to work approximately in the same focal plane. The apertures are moderate, as is suitable for histological work; but the objectives are excellent ones, and will bear favorable comparison with any others in the market at

the same price. The price of the $\frac{3}{8}$ -inch is \$3.75, and of the $\frac{1}{2}$ -inch \$7.25. We had also an opportunity of examining a 1-inch N. A. .26 at 15s., and a 1-12-inch oil immersion N. A. 1.3 at \$24.50. This last was a really fine lens. The microscope, as described above, with double nose-piece, $\frac{3}{8}$ and $\frac{1}{2}$ inch objectives, two eye-pieces, and mahogany case, is sold at \$35.25, or with Abbe condenser N. A. 1.2, with iris diaphragm, \$7.25 extra.

STANDARDIZATION OF SUB-STAGE AND DRAW-TUBES.—The Royal Microscopical Society, which has already done so much for the standardization of the various parts of the microscope, and whose standard for the thread of objectives, known as the "Society Screw," is now adopted by opticians throughout the world, has passed some important resolutions with regard to the standardization of the sub-stage and of the internal diameters of the draw-tubes of microscopes. There are few workers who have not experienced the annoyance and difficulties caused by the present want of uniformity among our leading makers. The present step is yet another in the direction of uniformity, though we could wish it had been a more firm and decided one. As it is, it will not do away entirely with the evil complained of, even if makers can be persuaded to adopt its somewhat various suggestions. The resolutions arrived at by the Council on December 20 last were: that the standards adopted by the Council in 1882 be withdrawn; that the standard size for the inside diameter of the sub-stage fitting be 1.527 inches (38.786 mm.); that the gauges for standardizing eye-pieces be the internal diameters of the draw-tubes, the tightness of the fit being left to the discretion of the manufacturers. Further, that the following four sizes of the internal diameters of the draw-tubes be adopted:—R. M. S. No. 1, .9173 inch (23.300 mm.); R. M. S. No. 2, 1.04 inches (26.416 mm.); R. M. S. No. 3, 1.27 inches (32.258 mm.); R. M. S. No. 4, 1.41 inches (35.814 mm.); and that plug and ring

ganges of all the above sizes be kept in the Society's rooms; also that the public, on payment of a small fee be allowed to inspect them. The size of the sub-stage is that now in fairly general use amongst English makers, the variations being not more than a few thousands of an inch. The sizes of the eye-pieces are arrived at as follows:—No. 1 is the Continental gauge; it is in general use on the Continent, and has been adopted by several of the English makers for their students' size instrument. No. 2 is the mean of the sizes used by the English trade for students' and small microscopes, and is apparently meant to meet the objections of those makers who have hitherto clung tenaciously to their own originally adopted sizes. No. 3 is the mean of the sizes used for medium-sized binoculars and other microscopes of a similar class, and is apparently also an attempt to meet the objections of those makers who have hitherto declined or been unable to adopt the Society's standard. The standard adopted by the Society for this eye-piece was formerly 1.35 inches, and therefore those makers who fell into line and adopted this size will now have to alter everything—which seems to us a somewhat ungrateful return for their loyalty, and likely to inconvenience equally those who already possess microscopes made to the old standards. Size No. 4 is, we think, that adopted by Messrs. Powell & Lealand alone, and is not likely to become general, as it is too large for most instruments. We cannot help thinking that two standard sizes only would have been better—the Continental size for students' instruments, and No. 3 size for large instruments. However, we are grateful for any advance in the direction of uniformity, and earnestly trust that all our leading makers will now adopt these standards. Buyers of microscopes could materially assist by insisting on their microscopes being made in accordance with the Society's standards. We may add that the standardization of the eye-piece, will follow shortly.

DARK GROUND ILLUMINATION.—The size of the stop must be proportioned to the aperture of the objective; the higher the aperture the larger the stop. Try making various stops for yourself out of blackened cardboard.

DISSECTING.—It can be done with the simplest apparatus, but some form of dissecting microscope or stand is a great convenience, and an actual necessity where much or prolonged work is done. The microscope itself can be used together with the lowest-power objective, but in this case the image will of course be inverted, unless what is called an "erecting lens" be used. To protect the stage, Mr. West's table stage, is a most simple and practical device; it is provided with hand-rests, and can be used also as a mounting-table. There are, of course, different types of dissecting-stands made by the opticians, of which, perhaps, the cheapest is Leitz's small dissecting microscope, sold at \$5 without lenses. A small stand can be made at home by any one able to use his hands, and that will cost but a few shillings. The design itself is not original, as a similar but more elaborated stand is figured in opticians' catalogues at \$10. and upwards. The total length should be about 14 inches, and the width about 4 inches. The sloping rest for the hands might be, say, 2 inches high at the lowest ends, and 4 inches at the highest. This latter measurement, however, should be governed by the size of the mirror, which must have ample room to swing. The mirror itself is a simple penny mirror such as can be bought at any toy-shop, and it is let into a piece of wood which swings on wooden or metal pivots between the two centre uprights. This piece of wood could be hinged to the bottom of the stand instead; but in that case the mirror would not remain central when lifted at an angle. A little more skill would be required to arrange universal movements. The stage is a piece of plate-glass 5 inches x 4 inches, ground at the edges, and can be ordered at any glazier's. It lifts out, if necessary.

Two pieces of cardboard of the same size should be cut to go underneath when required ; both should be covered with black paper, and one should have a hole about $1\frac{1}{2}$ inches in diameter in the centre. The whole stand might be made of wood $\frac{1}{2}$ inch thick, mahogany being preferable to pine, and the dovetailing or grooving should be finished as carefully as possible.

The holder for the lenses can be made, by fitting a piece of $\frac{1}{4}$ -inch brass tube about 8 inches high into a small stand, say, $2\frac{1}{2}$ inches in diameter. A piece of springy $\frac{1}{8}$ -inch brass wire is then rolled several times tightly round the upright as shown ; one end is turned up about 3 inches away from the stand, and the other end is shaped into a ring to hold a watchmaker's eye-glass. This last can be bought anywhere for 25 cents, and makes a most useful dissecting lens. On the turned-up end can be put an ordinary pocket-magnifier in ebonite mount, such as can be bought for 25 cents and upwards, according to the number of lenses.

This stand, simple though it be, will be found a useful and efficient piece of apparatus. It will be money well spent, however, if the beginner provides himself at the outset with one of the beautiful aplanatic lenses sold by all the principal opticians. They give exquisite definition together with a flat field, are excellent for dissecting, and are also the most perfect of those magnifiers which the real microscopist can always bring forth from his pocket when wanted. The most useful powers do not exceed ten magnifications, and a lower power gives a larger field and greater working distance.

For dissecting requiring to be done under water or methylated spirit, a piece of cork loaded with lead is useful ; or a mixture of paraffin and stearine may be run into the bottom of the dissecting-dish. This paraffin mixture is transparent, which is generally an advantage ; but where an opaque background is needed a mixture of bees-

wax and tallow darkened with lamp-black can be used instead.

The dissecting-dishes themselves can be obtained in many different forms from the opticians. A very useful one can be manufactured at home from a piece of gutta-percha, as suggested by Dr. Carpenter. A piece of gutta-percha of suitable size and thickness is warmed until it is sufficiently flexible, and then the four sides are turned up to make a dish somewhat similar in appearance to, but of course much smaller, than an ordinary photographer's developing-dish. One corner can be shaped into a spout for emptying.

Very useful for small dissections are the flat glass capsules sold at from \$1.00 to \$1.50 the dozen. These are hollow cells ground in square solid blocks of glass, with a piece of plain glass lying on the top as a cover. They are not only useful for dissecting, but form convenient receptacles for stains, clearing solutions, &c., as a thin film forms between the capsule and the cover when the latter is in place, and keeps the contents from evaporating. For staining sections, however, we have found an ordinary artist's porcelain palette, with wellied divisions, as useful as anything, and the white back-ground is often of service.

BIOLOGICAL NOTES.

L. H. PAMMEL.

AN INTERESTING SOIL ORGANISM.—Dr. W. C. Sturgis (Trans. Royal Phil. Soc. 191: 147-169 pl. 14-16) gives an interesting account of a soil bacillus, the *B. hortulensis* Sturg. which is closely allied to *B. megatherium*. It is characterized by its large size and its marked predilection for acid saccharine culture media. The cheesy growth on agar becomes gelatinous when transferred to saccharose-gelatine and the viscous slime on potato produces

firm small circular colonies on peptone gelatine and vice-versa. These differences appear to be due to the presence or absence of a gelatinous sheath investing the rods, and always accompanying a vigorous growth in the presence of carbohydrates, especially cane sugar. The gelatinous sheath is very evident when grown on potatoes, and the growth becomes quite viscous. When grown in peptone gelatine and other media devoid of carbohydrates, the sheath is much reduced and the growth is neither gelatinous nor viscous. The gelatinous sheath is very evanescent. It gradually disappears with repeated cultures even on saccharose gelatine, in two or three transfers assumes the form and size seen on peptone-gelatine. Special media and age greatly influence motion of rods. In saccharose broth they are actively motile. Involution forms are produced in great numbers under unfavorable conditions and in old cultures. In one end of the rod an oval highly refringent spore is produced. The species is clearly allied to *B. subtilis*, *B. megatherium*, and *B. mesentericus*.

INFLUENCE OF PURE METAL ON PLANTS.—Copeland and Kahlenberg give an abridged account in the Pharmaceutical Review (17: 548) on the above topic. Frequent observations have been made showing the tendency of distilled water to be injurious to certain plants. Every metal in contact with water and air is subject to some change. When this chemical action is sufficient for the effect to become visible the metal is tarnished or corroded. The salts formed under such conditions are known to be poisonous. Some metals are more resistant to corrosion than others, e. g. gold, platinum and silver. The authors conclude that those metals poison plants when present in water whose salts are known to be toxic, the salts acting in their ordinary characteristic ways, kill the plants. In plant toxicology as well as animal toxicology, the phenomena of stimulation and of poisoning are intimately related. The proper application of copper stimulates

the production of sturdier leaves and more chlorophyll. Cobalt likewise exerts a stimulating influence. Boron, lead and tungsten exert in some cases a stimulating influence. A somewhat similar line of investigation has been carried on by Clark in a paper on the toxic effect of deleterious agents on the germination and development of certain filamentous fungi (Bot. Gazette 28: 289). Hydrocyanic-acid so deadly to higher vertebrates is much less toxic to less highly organized structures. To moulds it acts as one of the most fatal poisons. *Oedocephalum* is particularly sensitive to this agent.

USEFUL PLANTS OF MEXICO.—Dr. J. N. Rose (Contr. U. S. Nat. Herb. 5: 209) is the author of an interesting treatise on the useful plants of Mexico, containing a large number of excellent plates. The paper is an admirable contribution to our knowledge of the plants of that country.

MINNESOTA PLANT LIFE.—In his preface to Minnesota Plant Life, Prof. Conway MacMillan says: "It has been well said that the main difficulties with the book on popular science are that, if popular, it will not be scientific, and, if scientific, it will not be popular." Prof. MacMillan has certainly succeeded admirably in presenting scientific facts in a popular style. His literary style is excellent and the matter is treated in a very pleasing manner. The story of plant life is told lucidly, the book contains in addition a superb lot of illustrations. The State of Minnesota has published an edition of 10,000 copies to be distributed to the public schools of the state. There is no doubt that the work will have a large influence in teaching the school children of that state that plants are living things, and not merely to be classified and named. "Certain plant individuals and societies are brought before the reader as having life problems of their own, not as mere material for economic, anatomical or

classificatory industry." The humblest as well as the higher plants are discussed, bacteria, rusts, smuts, moulds, blue-green algae, mushrooms, club fungi puff balls, blights, mosses, lichens, ferns, club-mosses, grasses and sedges and other higher flowering plants. Chapters on adaptations of plants to their surroundings, hydrophytic, xerophytic, halophytic and mesophytic plants, the maintenance of the plant individual and subjects of this kind are likely to awaken enthusiasm among the young. The book is most commendable and we bespeak for it a hearty reception.

TEXAS CATTLE FEVER.—Francis and Connaway (Bull Texas Agrl. Exp. Sta. 53:55) conclude from some elaborate experiments that in careful hands and with proper management, preventative inoculation is a reasonably safe and practical measure against the fatal type of Texas fever.

PENICILLIUM GLAUCUM AND PELLAGRA.—Gosio (Riv. d'Igiene No. 21 & 22) gives the results of chemical and bacteriological studies and its relation to the aetiology of the so-called Pellagra disease. The author isolated bacteria and moulds. *Penicillium glaucum* was most abundant of these. The cultures of the mould obtained from such sources proved to be poisonous. The mould growing on maize produces a ferment which gives a reaction for phenol. Maize extracts on which this mould was grown produced toxic affects on rabbits when subcutaneously or intravenously injected. Carraroli (Gior Soc. ital d'Igiene No. 7 & 9. 250) describes a bacterial organism the Pellagra bacterium found in maize meal which produces toxic poisons to which the pellagra disease is due.

DWARFING OF ALPINE PLANTS.—Gaston Bonnier (Compt Rendus. 127 : 307) in some experiments conducted to determine the production of alpine characters of plants concludes that hygrometric conditions do not influence growth to any marked degree, but that variation in tem-

perature is the most important factor in the dwarfing of alpine plants. The assimilative power per unit of surface of the leaf showed a great increase (Compt. rend. 128: 1143) in the specimen grown under alpine conditions.

LAKE FLORA.—Prof. G. E. Stone who has published a short paper on the Flora of Lake Quinsigamond found quite a large number of algae. The most satisfactory preserving fluid is glycerine one part, water two parts, alcohol three parts.

L. H. PAMMEL.

Miscellaneous Notes on Microscopy.

JOHN. H. COOKE, F. L. S., F. G. S.

CARBOLIC ACID.—Collections of material kept in damp places, or in a moist atmosphere, are very liable to mould, and under such conditions it is difficult to avoid this evil. Carbolic acid is recommended, but Mr. Ashmead, who has kept a large collection in the moist climate of Florida, has found the use of naphthaline much more satisfactory. Mr. H. H. Smith, who has had more extensive experience in the tropics, prefers the carbolic acid. Mouldy specimens may be cleaned by washing with carbolic acid applied with a fine camel's hair brush.

CEMENT.—Asphalt, dissolved in spirits of eturpntine, is one of the best mediums for sealing cells, and, provided that no traces of the mounting medium are left on the edges of the cells before applying the solution, the cement will keep unchanged for years.

DIATOMS.—The propagation and growth of diatoms are influenced to a marked extent by meteorological conditions. They increase most rapidly during those seasons of the year when the water is in circulation throughout the vertical currents. The vertical currents keep the diatoms near the surface, where the light stimulates their growth, and where there is an abundance of air and food.

CRYSTALS.—The forms of microscopic crystals may be accurately reproduced on glass by etching with fluoric acid. Interesting and beautiful effects may be obtained by crystallizing various salts in a thin layer on a glass slip which has been well warmed to prevent the crystals from dissolving, and then exposing the glass to the action of the vapor of fluoric acid for three or five minutes.

INSECTS.—Many Aphides and Coccids are covered with a waxy secretion which interferes very materially with their easy examination. To remove this waxy secretion place the insect on a piece of platinum foil and pass it once over the flame of the alcohol lamp. The wax melts at a surprisingly low temperature, and leaves the insect perfectly clean for study. This method is particularly useful in the removal of the waxy cocoon of the pupæ of male Coccidæ, and is quicker and more thorough than the use of any of the chemical wax solvents which have been suggested.

OBJECTIVES.—Oil-immersion objectives require much care in use. A small quantity only of the fluid should be employed, and then wiped off as soon as possible when finished with. The removal of the prepared cedar oil, which is generally used, should be effected with blotting paper, and the lens cleaned by first breathing on it and afterwards wiping lightly with a piece of clean, soft linen. To keep the immersion fluid unchanged it ought not to be exposed to the air for any length of time, as free access of air results in thickening and consequent alteration of the refractive index.

A TELE-MICROSCOPE.—A kind of combination telescope and microscope has been worked out by a French microscopist for studying live insects and their habits. The new apparatus is called the "telemicroscope," and is really a small telescope having an objective formed of two achromatic lenses, which can be moved nearer together

or separated by sliding the tubes. For the purpose intended, the magnifying power necessary is only 10 to 15 diameters. Besides serving for watching insects moving on the ground, the instrument, it is stated, is admirably adapted for use as a field glass.

STANDARDS.—Microscopists, both at home and abroad, will hail with satisfaction the resolutions that have recently been adopted by the Council of the Royal Microscopical Society to standardize the various parts of the microscope and its accessories. A beginning has already been made, for the details of which we are indebted to the courtesy of the Council. The standards adopted in 1882 have been withdrawn, and the size for the inside diameter of the sub-stage fitting has been fixed at 1.527 inches (38.786 mm.). The gauges for standardizing eyepieces will, in future, be the internal diameter of the draw-tubes; the tightness of the fit being left to the discretion of the manufacturers. Four sizes of the internal diameters of the draw-tubes have been fixed as follows: No. 1, 9.173 inch (23.300 mm.). This is the Continental gauge. No. 2, 1.04 inches (26.416 mm.), is the mean of the sizes used by the English trade for students and small microscopes. No. 3, 1.27 inches (32.258 mm.), is the mean of the sizes used for medium-sized binoculars and other microscopes of a similar class. No. 4, 1.41 inches (35.814 mm.), is the maximum size for long-tube binoculars. The sub-stage gauge is that which has been used by the English trade for many years past, the variation among different makers being not more than a few thousandths of an inch. We hope to be able shortly to give the standard gauges of the eye-piece cap and of other apparatus. The plugs and ring gauges of all of the above may be inspected by the public at the Society's rooms.

FUNGI.—With all the diversity of interesting lines of research that are offered to the student of botany to-day,

there is none more inviting to a student, or better adapted to bring into activity all the resources of his judgment, than the systematic study of the species of some limited group, provided this is properly combined with a study of the morphology, development, and ecologic relations of such a related series. The Fungi and Mycetozoa offer themselves, in a special degree, as a field for thorough and original systematic study, and students of these groups will therefore be glad to hear that Professor Lucian Underwood, of Columbia University, has just issued, in book form, an admirable exposition bearing on the moulds, mildews and mushrooms.

AIR-BUBBLES.—A simple and effective method for removing air bubbles from microscopic mounts is suggested by P. S. Proctor. A small syringe, having a glass barrel, vulcanite mounts, and leather packing to the piston, is the only apparatus required. Select one that is as nearly as possible air tight, unscrew the top and remove the piston. Close the nozzle with a small piece of beeswax, half fill the barrel with distilled water, and into this drop the section or tissues to be treated. Replace the piston and screw on the top. The syringe being inverted and the plug of wax removed, the air is driven out of the barrel by raising the piston till the water begins to flow out of the nozzle, after which close the aperture with the finger and lower the piston. A partial vacuum is thus formed, and the air rapidly escapes from the cells of the tissue, collecting in the point of the syringe. By removing the finger and raising the piston the liberated air is forced out; this may be repeated several times as long as air is being expelled from the material. The same mode of operating is applicable to objects that are to be mounted in Canada balsam if oil of turpentine be used instead of water, and if the objects to be mounted are quite dry before immersion in the turpentine.—*Knowledge.*

Report of the American Postal Microscopical Club.

R. H. WARD.

The membership of the Club varies but little from year to year. Many of the members most active and interested now are those of the Club's earliest years; and they are as ready to give and receive pleasure today, in the cultivation of this most interesting field of labor, as they were twenty or twenty-five years ago. The losses in membership during the last few years, from resignation or otherwise, have fortunately been very few and for unavoidable reasons; but the task of filling the vacancies thus produced becomes constantly more difficult, not only from the exuberant growth of latter "fads" which stampede into other directions a certain proportion of those who would most naturally have been specialists here, but also, and much worse, from the increasing narrow-mindedness produced by the excessive specialization of the day which renders many of those who "use the microscope as a tool" unable to feel an interest in other lines of work and incapable of taking a comprehensive view of the broad subject. "The only defect is a decrease in the number of those who have a keen interest in the broad field of microscopy in general, without limiting their interest to their own little patch." There is nearly always room for a small number of such applicants, and the management will always be glad to hear of them from members.

During the year we have lost by death one member, Mr. Richard H. Oakley, of Cleveland. Though a member of the Club for only three years, he had already gained a reputation, among all with whom he had dealings, for a prompt, faithful and enthusiastic performance of everything he undertook; and the management had long since learned to know him as one of "the faithful" who would do just right every time. He was thirty years of age, and his occupation in a bank gave him leisure hours which

were devoted to the improvement of his education in the direction of his natural talents. He took up the study of nature, and frequented the fields and woods. He had a keen, quick eye, and a clear conception which enabled him to see things in their true relations. With the advice and encouragement of a friend who was already an adept, he soon obtained a fair mastery of the microscope, and then supplemented its use with the camera; and his photomicrographs were highly commendable. When taken sick, he was engaged in making lantern slides of insect anatomy, a subject into which he had drifted in the natural development of his own tastes, and in which he was preparing to make extensive studies.

SLIDES AND NOTES.—During the past year the new "Ea" series of special boxes, mostly 2-slide, has been in full service; and this, with the regular circuit boxes of the "A" and "A²" series, has given an adequate supply. While there is still the inevitable inequality of character in the various slides and boxes, there has been much that was interesting as a study of progress, and not a little that was positively instructive to the most capable.

Five valuable special boxes, of six slides each, have been generously contributed during the year; one, of Fly sections, by Prof. T. D. Biscoe; two, a study of spiders, by Mr. Thos. J. Bray; one of Anatomical preparations by Dr. H. M. Farr, and another by Dr. H. M. Slaughter. While it would be impracticable and invidious to speak comparatively of these gifts, all of which are excellent it is only fair and proper to say that one of them was incomparable in at least one respect. The box by Prof. T. D. Biscoe, is not only of the first class in every way, with fine sections and scholarly notes, as is all his work, but is abundantly illustrated with drawings that are absolutely unique, elaborate and exhaustive, and finely drawn and perfect as the finest steel engraving, and easily the best set of illustrations ever presented to the Club.

Some comments among various notes contain useful suggestion ;

"These slides are evidence that some of the best working members are not experts in preparing mounts. Objects like these are not easily prepared so as to show structure and also make a a faultless mount; but the mounts are very valuable and interesting to the microscopist and student, and are examples of serious work, of which more are much desired.—S. G. S."

"The foreign sponges are good and instructive, but why does not some student of our own fresh-water sponges send around a box of them so that we can gather material for study and verification? These sponges are to be found almost everywhere in brooks and fresh ponds, attached to submerged debris, and they are exceedingly interesting.—C. N. A."

Some member, of a sharp eye, great ingenuity and endless patience, has succeeded in deciphering the valuable note, which was written with pale grayish ink and was absolutely illegible to ordinary inspection, and has appended to the original note the translation, with a fine pen and black ink on fine thin paper, giving a fine object-lesson of the possibilities of compact, beautiful and legible writing.—R. H. W.

The following comments, from among many more of the same kind, may serve to show to those who have taken the pains to put good work into their slides and notes, that their efforts have proved useful and have been intelligently appreciated:

"You who live in the East do not appreciate how valuable the boxes of slides are to those of us who are farther removed from contact with the best scientific work. My classes look forward with great interest to the coming of the boxes, and we almost always find something helpful, and always something interesting in them.—* * *."

"There is most interest in home-made slides, even if

they are not pretty ; the mounter learns so much more about the object, and he can explain its preparation so much better. I always find more interest in the slides prepared by club members than in the very finest of purchased slides.—* * *

"I have received some very fine boxes this year, and wish to heartily thank the gentlemen who have supplied the very interesting and valuable notes to the slides.—* * *

"A beautiful mount, an evening's study. Examine with polariscope, and the crystals will show up well.—* * *

CIRCULATION.—Again we are indebted to our devoted Secretary, Dr. Shanks, for another year's successful handling of the department of Boxes and Circulation. A minimum of a dozen boxes has been got through all the circuits, and in many cases somewhat more. Members who desire, as who does not ? to show their appreciation of the Secretary's unselfish labors for the interests of the Club, can do so most delicately and successfully be undertaking, in the little portion in which they personally participate, to see that there shall be no mistakes to correct or faults to regret.

NOTES ON SOME OF THE SLIDES.

Trichinosis.—It is now known that the gravid female, for the Trichina is viviparous (better ovoviviparous), bores her way into a villus, and lying with the vulva in a blood or lymph vessel gradually discharges the embryos into its stream by which they are carried to where they enter into the resting stage. They leave the blood current in a capillary where the diminished flow and the thinner walls make penetration possible, and this takes place only (with some rare exceptions that may be apparent rather than real) in muscular tissue. Once free, an embryo passes into a fibre, the substance of which disintegrates and the sarcolemma forms the beginning of the cyst. Here the cyst wall is rather thick, showing that the invasion was not at all recent. In

one case near the actual left of the specimen, I think there is the rare phenomenon of two individuals in one cyst. It should be born in mind that not all such encysted round worms are *Trichinæ*. It is very difficult to say from sections, unless especially clear and well-stained, whether the form is a trichina or of some other genus. In the short time available for the study of this slide I did not find any distinguishing feature. The so-called "cell body" of the oesophagus is absolutely distinctive so far as present knowledge goes.—H. B. WARD.

Dermoid Cyst of Human Ovary.—This cyst was of the size and shape of a large orange. It was composed of a cyst wall of which this section was a part, and a central cavity full of fluid and large dense masses of sebaceous matter and a wad of coarse hair as large as an egg, the separate hairs of which were of almost indefinite length. So closely were they woven that it was well nigh impossible to extricate a single hair without breaking it. Several large and well formed molar teeth were also loose in the cavity, and many smaller ones, as well as bits of bone, were growing from and in the wall of the cyst, as I quickly found, to the damage of my knife, when attempting to cut a section in the microtome. There were also numerous calcareous masses, so that, as a whole, it was rather hard to cut, and my knife has never yet fully recovered its health. The cyst wall was thick and solid, almost cartilaginous, covered inside with nodules and with many hairs growing into the cavity. The most probable etiology is given in the Ref. Handbook Medical Sciences, 5, 417.

"These growths are located where during fetal life fissures exist; and it is usually accepted that an inclusion of the external germinal layer having taken place, it adheres in the abnormal situation and grows, with the performance of its function the same as though properly placed."—W. H. SYLVESTER.

Sphærozoum Punctatum.—This specimen of Radiolarians, supposed to be from the south of the British Channel, is given as an example of the "Sea-jellies," or Collo-

zoa, which are very common in warm seas. Though brought up abundantly by the tow-net when collecting in such regions, they are perhaps somewhat less familiar, at least to inland microscopists, than those other, more highly developed and more showy radiolarian groups which are roughly classified and highly admired as "Polycystina." It will be noticed that these are composite forms, of which the numerous globular zooids are of the familiar radiolarian type, but whose skeleton has not attained a greater dignity or utility than that of a few slender, branching, silicious spicules (suggestive, in general appearance, of some sponges) that surround the individual zooids, and protect them more or less, in lieu of the comparatively massive and elaborate "silicious skeleton" of the nearly related Polycystina groups. The form and arrangement of the delicate and beautiful spicules is best seen with a stereoscopic binocular (as Wenham's) and a $\frac{2}{3}$ rds or low-angled 4-10ths obj. The "punctate" appearance of the globules, which may well have given rise to the specific name, is readily seen with the same powers. If using a $\frac{1}{4}$ th or 1-5th, which is seldom advisable, use only those of low angles and long working focus, and use with very great care; as the specimen is thick, and many a $\frac{1}{4}$ th would destroy the mount before focusing through the object.—R. H. WARD.

Midrib of Leaf of Strelitzia.—This section is from the midrib portion of the leaf of a south Africa monocotyledonous plant of the banana family. It is specially interesting for the gigantic size, especially antero-posteriorly, of some of its fibrovascular bundles; also for the very large-celled, frail, thin-walled and loosely-packed parenchyma, which has been unable to fill, even with that poor tissue, all the area of the section, but has left large air-spaces, besides a liberal supply of the ordinary ducts, and of giant size. The vacant spaces occupy, from a quarter to a third of the whole area. All these peculiarities are evidently due to the rapid growth, especially in thickness, of this member; such exuberance of growth being well-known in the banana plant and other members of the same family. There will be noticed, also, the very highly differentiated and perfect though

single-layered, spithelium, the massing of sub-spidermal parenchyma, and the finely-formed crystals scattered abundantly in various parts of the section.—R. H. WARD.

Muddy Deposit Inside of Steam Boilers.—These deposits vary in appearance and composition according to the water and the conditions attending, even clear well water being not exempt. This specimen was removed from a boiler in constant use for power purposes, before becoming solidified into crust or "scale." On cursory view, the appearance is much like some very fine sand, mixed with organic matter—the latter being found in greater or less quantity, in almost every case. But on closer examination with higher power and condenser, and also with polariscope and paraboloid, it will be found to be of different character. What takes place in ordinary course seems to be this: the heat precipitates salts from solution in the water, and these settling to the lowest point cover the surface of the interior of the steel of the boiler, and after a time prevent its contact with the water. If neglected the deposit fuses or "bakes," and often becomes very hard and difficult to remove. The furnace fire overheats the boiler shell at that point, where without water contact, and finally "burns" it. The steel of the shell loses its tensile strength, becoming "crystallized" and brittle. If nothing more serious occurs, the plant or factory must be shut down while the boilers are "patched," and a patched boiler must usually soon be replaced. The surest safeguard is not chemical solvents, but frequent and thorough inspection and cleaning.—J. S. DALES.

Wanted.—Earth containing diatoms from Redondo Beach for a European subscriber who offers cash, or, in exchange, Hungarian diatomaceous material from St. Peter. C. W. S.

Slides.—The distinguished diatomist, Dr. Grunow, has presented a very large collection of slides to the Imperial Natural History Museum at Vienna. A carefully prepared selection of microscopic slides made by the late W. T. Suffolk has been given to the Royal Microscopical Society.

MICROSCOPICAL SOCIETIES.

The Academy of Science of St. Louis.—At the meeting of the Academy of Science of St. Louis of February 5th, 1900, some 250 persons were given a demonstration of the use of the microscope in the sciences, arts and industries, by experts, under the direction of Dr. H. M. Whelpley as follows: Anatomy, Dr. R. J. Terry, Bacteriology, Dr. Amend Ravold; Blood examination, Dr. Ludwig Bremer; Botany, Mr. H. F. Roberts; Diseases of forest trees, Dr. H. Von Schrenk; Drug adulterations, Mr. O. H. Elbrecht; Flour Inspection, Mr. Victor Goetz; Insects parasitic on man, Mr. C. F. Baker; Living protoplasm, Dr. Otto A. Wall, Jr.; Microphotography, Mr. Robert Benecke; Mineralogy, Dr. G. Hambach; Photographic dry plate testing, Mr. Robert Benecke; Photomicrography, Dr. Adolph Alt; Physiology, Dr. Hartwell N. Lyon; Seed adulterations, Mr. F. M. Maas; Spice adulterations, Mr. William K. Ilhardt; Textile fibers, Mr. Peter J. Weber, Jr.; Trichina, Dr. C. C. Crandall. The Historical Society rooms were open to the Academy members and their guests. The Society's important collections, as well as the demonstration offered by the Academy, proved a source of interest and instruction to the ladies and gentlemen present.

William Trelease, Recording Secretary.

MICROSCOPICAL APPARATUS.

A Photomicrographic Apparatus.—By Dr. W. Measures, made by Messrs. Zeiss, of Jena. The apparatus comprises a microscope and camera for the photography of minute objects, and a lantern for the projection of microscopic slides. The lantern can be readily adapted for the exhibition of ordinary lantern slides, and also for projecting images of opaque objects on the screen. The camera is fitted on a separate stand, with a simple arrangement for attachment to the microscope, and another for focussing. When the lantern is to be used it is only necessary to remove the stand bearing the camera, and the rest of the apparatus is

immediately ready. For microscopic projection the microscope is fixed on a sole plate, and brought into use in a moment, or quite as quickly moved aside to allow for the projection of ordinary lantern slides, or opaque objects by incident light. The electric light was employed, a special installation having been arranged for the purpose; but the lantern is also adapted for the limelight and other modes of illumination. The exhibition opened with the projection on the screen of the surfaces of old and new silver coins, a method capable of useful development in rendering visible the chemical changes in metals. Some opaque objects were then shown by reflected light, comprising postcards, diagrams, coin, a watch, and butterflies, set on card, but not otherwise prepared. The lantern was then fitted with the new microplanar lenses, and micro-slides of insects, vegetable tissues, and pathological preparations were thrown on the screen. The great advantages of these lenses is their high power of definition, all the parts of a picture coming out sharp, the feet of the insects and the edges of the tissues being as well brought out in detail as the body of the one or the central portions of the other. The last part of the exhibition consisted of lantern slides of diatoms, photographs of micro-slides, and some general views. In this part the best was undoubtedly a projected slide of a podura scale, the well-known test used by microscopists for defining the penetrating power of a lens.

MICROSCOPICAL NOTES.

Sportive Habits of Melicerta.—Anyone who has seen this helpless, awkwardly swimming creature when it has had the misfortune to become detached and to be driven out of its tube, will be much interested to hear that it can dart about, in and out of its house, hide behind grains of sand with one eye over the edge or round the corner, and do other frisky gambols with a little preseverance and a grain or two of imagination. *Melicerta* can be seen to use its foot as a prehensile organ, in fact, like an elephant his nasal trunk. When a small rotifer of the genus *Rattulus*

or Mastigocerca comes by, Melicerta will seize it, break off its long pointed toe, and use it as a tooth-pick to clean its teeth, of which it has quite a number, quietly sitting the while on the above mentioned grain of sand. The eyesight of Melicerta, with its vertebrate retina of rods and cones, is so powerful that it often tries to look at the observer through the other end of his (the observer's own) microscope, and, no doubt, succeeds. A wonderful creature is Melicerta, and, in order to observe all these and other marvelous habits, a good microscope and a little imagination only are required.—C. F. R.

Diatomaceous Earth.—Will any of our friends who have valuable earth to exchange with an expert in Austria please advise us.

"Meatless Dishes."—A cook book which tells how to prepare healthful and nutritious dishes without the use of meats or animal fats. Gives tested receipts for: Chestnut Soup, Tomato Soup, Barley Soup, Wheatmeal Biscuits, Oatmeal Biscuits, Wheat Crackers, Potatoes a la Duchess, Potato Omelet, Potato a la Creme, Tomato Rice, Potato Balls, Sweet Potato Pie, Potato Cheese Cake, Winter Fruit Salad. Contains an interesting sermon on salads by an expert cook. Gives useful hints on Hygiene, Kitchen Economy, Care of Cooking Utensils, etc. How to test Nutmegs, a way to Polish Knives, to Prevent Flatirons Rusting, best way to Clean Tumblers, Gas Fixtures and Dish Cloths; to improve the taste of Molasses, to Keep the Heavy Odor of Cooking from Saucepans, Pots and Boilers; to Make Stewing Fruit Boil quickly. Tells where to get Health Foods, etc. Mailed to any address on receipt of 10 cts. C. W. Smiley, Washington, D. C.

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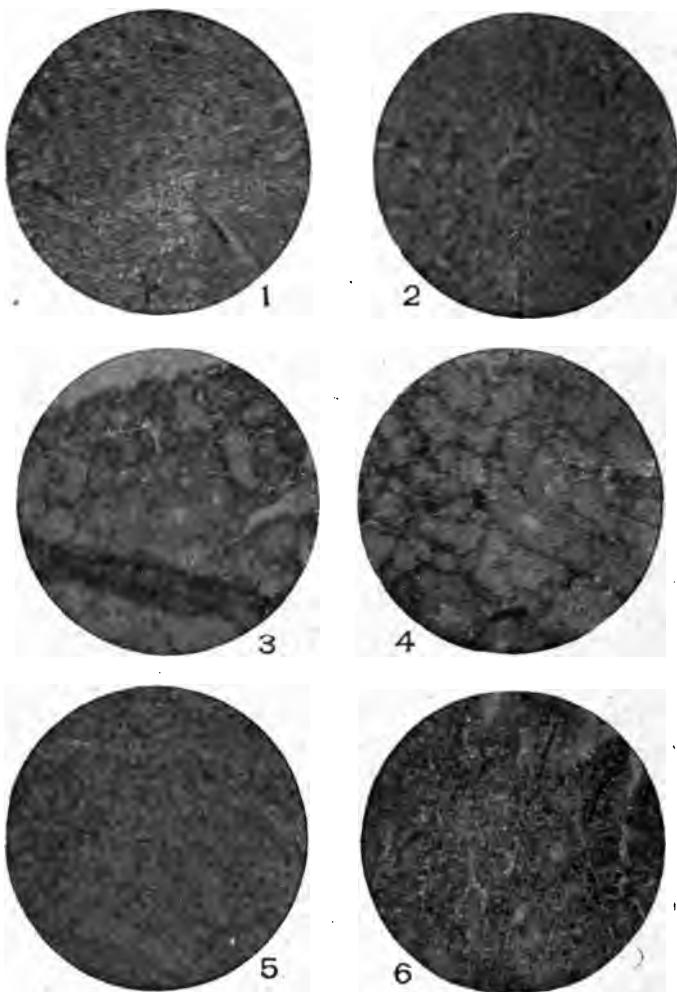
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CONTENTS.

Formaldehyde as a Killing and Fixing Agent. Carter. With Frontispiece.....	93-96
NOTES by J. H. COOKE.—Light; Herrings; Pork; A Show Slide; Action of Bacteria on Leguminosæ; Aphides; Heronite; Resolution; Formalin; Diatoms; Plant Histology.....	96-100
EVOLUTION of the Bacillaria. Edwards.....	101-109
BIOLOGICAL NOTES—PAMMEL.—Hybrid Citrus, Tubercular Infection; Red Color of Plants; Heteroecius Rusts; Apple Canker; Udder Bacteria.....	110-112
NOTES by F. S. SCALES.—Quekett Club; New Objectives.....	112-113
POSTAL CLUB SLIDES.—Onyx; Jade; Isolated Slide; Putrefactive Bacteria; Locating Objects; Fish Scales; Mounting.....	114-118
MICROSCOPICAL SOCIETIES.—Quekett Club.....	118-119
NEW PUBLICATIONS.—Bacteriology; Botany; Chats about the Microscope.....	119-121
MISCELLANEOUS.—Vermin, Dust, Slides, Diatoms Wanted.....	121-122

Formaldehyde as a Killing and Fixing Agent.

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With Frontispiece.

Formaldehyde as a preservative has justly a very widespread use, but as a killing and fixing agent for histological purposes its use is much more limited than it is destined to be. My faith in formaldehyde as a killing and fixing agent dates back more than a year, when my attention was called to the very perfect condition of some tissues which had been kept for some time in a ten per

cent solution. Since then I have been carrying on some experiments hoping to find whether or not formaldehyde could be used for such purposes, and if so, what was the best formula to use.

The formula which has yielded the most satisfactory results for all tissues is as follows;

Formaldehyde 40 percent solution.....	50 cc.
Distilled Water.....	50 cc.
Glacial Acetic Acid.....	5 cc.

The principal requisites for any successful fixing solution are that it shall kill and fix the tissues just as quickly as possible, and at the same time it must not shrink the cells of the tissues. Another desirable quality in such a solution is that it be of such a nature that it may be removed as quickly as possible preparatory to the dehydration. All these conditions formaldehyde when used alone fulfills very satisfactorily, and it is especially true of the solution as given above.

I am aware that previous to this time formaldehyde has been in use as a killing and fixing agent, but so far as I can learn, never in solution stronger than ten per cent. It has also been used in the same solution with mercuric chloride but my experiments convince me that the presence of the mercuric chloride is not necessary; on the contrary, just as satisfactory results can be obtained from the formaldehyde alone. The solution of the strength given in the formula above has produced no ill effects upon any normal tissues with the single exception of the spinal cord, where the axis cylinder of the fibers seems to be damaged while the cells within the gray matter are left in perfect condition.

Tissues are killed and perfectly fixed by this solution in from six to twelve hours, though it seems to do them no damage if left in as long as twenty-four hours; from the fixing solution the tissues are kept about an hour in 50 per cent alcohol, from which they are placed from fif-

teen to thirty minutes in 75 per cent, then the same length of time in 95 per cent alcohol. From this point to paraffine the process is the usual paraffine method.

The tissues of the digestive system come out from this solution in the most perfect condition of any of the tissues of the body, though as before stated, the nerve fibres of the spinal cord are the only tissues which seem to be injured.

In fact I can see no difference in the condition of tissues thus treated and mounts of other tissues in my possession which have been subjected to other fixing solutions. One of the best results of the use of this solution is that tissues thus treated can be subjected to almost any stain desired with equally good effect.

The accompanying illustrations are from photo-micrographs taken for me by Dr. L. A. Reed of Jacksonville, Ill. Dr. Reed has been experimenting with the fixing solution composed of formaldehyde, mercuric chloride and acetic acid; his results exactly coincide with mine, proving that the absence of mercuric chloride does not affect the tissues, or, in other words, that formaldehyde is an excellent fixing agent.

Figures 1 and 2 are taken from sections of the spinal cord of a cat, showing the cells within the grey matter. The cut does not show the effect upon the fibres, but the excellent condition of the cells is apparent.

Figures 3 and 4 are from sections of the sub-maxillary gland of a cat. This, while not quite so clear as figs. 1 and 2 nevertheless shows how well the cells have been fixed.

Figures 5 and 6 are from sections of the mucous membrane, 5 of the stomach, showing the glands of the fundus; and 6, of the small intestine. Figure 5 is less clear than any of the others, but a close examination will show that here also the cells are in an excellent condition.

Photographs could have been made of other tissues in

as perfect condition, but these are certainly sufficient to emphasize the claim I have made for this solution, namely that as a killing and fixing solution it will yield, as it has yielded, excellent results.

What advantages are to be gained by the use of this solution? Briefly, these: In a large laboratory where fixing solutions are almost constantly used, and where the quantity as a consequence becomes great, decrease in expense is an item well worth considering. Here formaldehyde as a fixing solution proves invaluable, for it not only answers the purpose of other and more expensive solutions, but it also possesses the valuable property of preserving its strength when kept for some time. It may be made up in large quantities and used when desired without any diminution of its effectiveness. Finally, while this may not be the best or most perfect formula that can be prepared from formaldehyde, I am confident that others trying it will find that it will give satisfactory results, and the future will accord formaldehyde a prominent place as a fixing agent.

Miscellaneous Notes on Microscopy.

JOHN. H. COOKE, F. L. S., F. G. S,

LIGHT.—When photographing bacteria and other minute organisms, the cone of light should never be reduced by stopping down. Without a full sized cone of light, white diffraction lines will appear around the organism.

HERRINGS.—Mr. Henry F. Moore, of the United States Fish Commission, has recently published the results of his investigations on the food of herring. The staple diet of these fish consist of minute organisms, often of microscopic dimensions. Examinations of the stomachs of the fish showed the food to consist largely of copopods, schizophods (shrimp-like forms), amphipods (sand fleas and their allies), the embryos of gasteropods and lamellibranchs,

and young fishes, often of their own kind. Many of these possess phosphorescent spots, due to the presence of photo-bacteria, which enable the herring to follow their prey by night. Mr. Moore has often watched the herrings at night swimming backwards and forwards in search of their prey, "apparently screening the water, their every moment traced by a phosphorescent gleam evoked perhaps by the very organisms which they are consuming."

PORK.—The necessity for exercising great caution in the use of pork as food is again brought home very forcibly to us in the last report of the microscopist of the Department of Agriculture. In the microscopical inspection for trichinæ, 1,881, 309 specimens were examined, and of these 13,325 were found to be infected. The expenses connected with this examination cost the Government 11,669 dollars.

A SHOW SLIDE.—Salicylic acid crystallized from alcohol gives, when mounted, a beautiful combination of gold and green, with shades of purple and silver points. The method of mounting is as follows:—Dissolve the acid in alcohol and allow a drop of the solution to fall on the slide. Apply heat for a few seconds, and when cooling the preparation with balsam and allow it to set. It may be necessary to super-impose several rings of balsam, but in each case the lower ring should have thoroughly set before another is applied. Slightly warm a cover-glass and place it on the ring. The cell may then be sealed with asphaltum and finished according to taste. The preparation is most effective as a "show" slide.

ACTION OF THE BACTERIA OF LEGUMINOSÆ.—Nobbe and Dr. Hilltner have induced nodule formation in plants by inoculation with pure cultures. To make pure cultures a fresh nodule is washed carefully, and after being dried in blotting paper, it is dropped for a moment into corrosive sublimate to kill any bacteria on the surface. It is

next washed in absolute alcohol, and cut with a scalpel that has been sterilized in a flame. A platinum needle is dipped into the cut, and gelatine, previously prepared with a decoction of leguminous shoots, is streaked with it. The bacillus radicicola, being an ærobic form, requires a large surface of gelatine for propagation. A pure culture is obtained in a few days. To inoculate plants with the microbe, the bacilli are transferred to water, and a little of the mixture is sprinkled over the soil in which the plants are growing.

APHIDES.—Minute soft-bodied insects do not lend themselves to methods of preparation that will enable them to be kept in a condition serviceable for subsequent scientific study. Alcohol deprives them of their color, and balsam frequently distorts, and so destroys the characteristics of venation and of jointed appendages. The method of roasting by the sudden application of intense heat has hitherto proved itself to be one of the best means of dry preservation. For Aphides the following procedure gives satisfactory results. The living *Aphis* is put on a sheet of white paper, and at the moment when it is in the desired position the paper is held over a flame, and in an instant it will be dead and will retain the attitude. Then put it, still on the paper, into an oven; or, still better, hold it over the heated tin, carefully watching the drying and moving the paper about in order to prevent it getting singed. The roasting is quickly accomplished in either way. If the paper burns brown it is a sign that caution is requisite. To pierce those brittle preparations is hazardous, and it is a better way to mount them with gum in a dry cell.

HERONITE.—In the course of some petrological investigations on the north shore of Lake Superior, Mr. A. P. Coleman discovered a new mineral, at Heron Bay, Lake Superior, which he has named Heronite, and which he de-

scribes at length in the *Journal of Geology*. It is a dike rock, consisting essentially of analcite, orthoclase, plagioclase, and *œ*gyrite, the analcite having the character of a base in which the other minerals form radiating groups of crystals. The analcite clearly represents the magma left after the crystallization of the imbedded minerals, and it is evident that it can be formed only from a magma highly charged with water, and therefore under pressure.

The labelling of microscopic objects, when done properly, forms a not unimportant part of the training of a microscopist. Apart from the discipline that it affords in habits of painstaking research, the systematic record that a label contains is a great time saver to the student, inasmuch as, when it is necessary to refer to the object again or to compare it with a series of objects belonging to the same genus, he is enabled to see at a glance the relation that each object bears to the other in the system of classification that is adopted, thus rendering further references to text and note books unnecessary. The labels include Sub-kingdom, Class, Order, Family, Genus, Species, Name, Section, Medium, Special Points, Locality, Mounter, Date, and should be printed in sheets and details filled in before the labels are trimmed to size. They are placed on the slide, one on either side of the object.

RESOLUTION.—The question of the limit of resolving power of objectives is discussed by Dr. L. B. Twitchell, who points out that up to the present, Nobert's twentieth band, 225,190 lines to an inch, has never been resolved, and, theoretically, with white light only 146,543 lines per inch can be distinguished. By utilizing, however, the shorter actinic rays and a photographic plate, theoretically 193,037 lines per inch should be resolved—that is, effects beyond the possibility of ocular vision.

FORMALIN.—Mr. G. E. Stone has used formalin in his laboratory for six years for the display of the morpho-

logical, physiological, pathological and ecological characteristics of plants with most satisfactory results. The strength of the formalin solution used for preserving specimens is four parts of the forty per cent solution to one hundred parts of water. Two to three parts to one hundred have been tried, but solutions of this strength have not proved satisfactory. Most of the specimens have been kept in a 4-100 parts solution for five years without renewing, and with the exception of a slight tendency to form a precipitate in some of the jars, they are as clear as ever. Formalin solution gives clear white colorless tissues, whereas the tissues placed in alcohol have invariably turned to a dirty brown.

DIATOMS.—Living diatoms survive for days when stained with methylene blue solution (one in one hundred thousand), but the vitality of the cells wanes from the moment the nucleus takes up the stain.

PLANT HISTOLOGY.—Prof. C. J. Chamberlain gives an admirable series of articles on methods in plant histology. He treats of the *Algæ*, fresh-water marine, and of the *Fungi*. Under the *Phycomycetes*, he briefly discusses *Mucor stolonifer*, the familiar bread mould, and suggests the following method as a sure and rapid method for obtaining it:—Place a glass tumbler in a plate of water, put a slice of bread on the tumbler, and cover with a glass jar. To obtain a good series of sporangia the material should be studied before the sporangia begin to turn black. There are phases in the life-history in the formation of the zygosporangium, which are rarely seen, and therefore the writer would be glad to hear from anyone who has met this phase, especially if the information could be accompanied by a few dry zygosporangia. A very satisfactory study may be made from the living material. Corrosive sublimate (four per cent) in fifty per cent alcohol, used hot, is recommended as a fixing agent.—*Knowledge*.

Evolution of the Bacillaria.

ARTHUR M. EDWARDS, M.D., F.L.S.

NEWARK, N. J.

I wish to set down in brief, so that it may be readily understood, what I judge was the evolution of the Bacillaria—in short, how the Bacillaria, that is to say the Diatomaceæ, came first, for they were the first to appear. That is why we find their remains back in the oldest rocks, for they have been found in the Lower Silurian. Evolution took place in them as it did once in all living things, and it does now; and I wish to state my knowledge of it, but it is by no means perfect. It is the knowledge of one who has acquired it in over forty years hard study,—study pretty constantly applied to the knowledge of them; first as animals, then as vegetables, and lastly as Protista, through the stimulus given to me by Bailey, Walker-Arnott and Brightwell.

The ordinary cell of a Bacillarian is a sphere, or rather was a sphere. For that is the shape that a mass of gelatinous matter assumes when left to itself. Fluid also assumes that shape. Now what is the shape of a Bacillarian? It appears in various forms. But the commonest; and one of the first to appear in spring, when the cold has broken up and the matter of the Bacillarian has a chance to form, is nearly a sphere. I mean what is known as *Cyclotella*. It was also one of the first to be named. It had been named by C. A. Agardh, in the *Botanische Zeitung* for 1827, *Frustulia*, from the Latin meaning little pieces or fragments. But F. T. Kutzin in his *Synopsis Diatomacearum*, in 1833, thought it looked like a little disc, which it does on one view, and gave it the name of *Cyclotella* from the Greek. Ehrenberg, in the *Abhandlungen de Berlin Akademie*, changed it to *Pyxidicula* from the Greek name of a box. And now we see that it is a box when viewed on the front side, the top and bottom of the box

being formed of the so-called frustules. On the other or, as it is called, the side view, it is of course round. But as on the front view, the frustules are more or less rounded, it becomes a sphere.

We must remember that we are looking at it in the prepared state, the Diatom, when the matter which forms it has been removed. Thus, we might have a man seen when he is dead and has been dead some time. In that case, we would have merely the skeleton left to name. This would be very different from the man himself and it would be idle to define man himself from the skeleton alone. But the skeleton of man is internal and the skeleton of a Bacillarian seemingly external. Nevertheless, to describe a Bacillarian in toto we must describe the skeleton and the internal parts also. Therefore we must describe the frustules and, if it is present, the connecting membrane likewise.

Cyclotella appears growing in fresh-water everywhere. When it grows or increases in volume, it does not do so by increase in the size of the individual, for that could not be, as the skeleton is of hard matter and cannot increase in bulk; but it grows by forming a new individual, which, for a time, is attached to the first individual and then becomes free. Another genus, as it is called, of *Bacillaria* is very common in streams and on the shore of the ocean everywhere. In fact, it is more common than that already described. This is known as *Melosira*. But this occurs as a chain of long threads of spheres and is commonly supposed to be a sea-weed or fresh-water plant or alga.

Melosira varians is very very common being found in fresh-water streams sometimes that run swiftly. It is found in the brackish water of marshes and then becomes *Melosira nummuloides*. It has been brought down by the streams where it grows as *Melosira varians* and is evolved into *Melosira nummuloides*. It grows as *Melosira*

nummuloides in salt-waters also and becomes *Melosira* *borreri* and others most likely.

Thus we can have a spherical form formed as *Cyclotella* and when attached in chains, *Melosira*. *Cyclotella*-like forms also occur in salt-water attached to sea-weeds as *Podosira*, single or double or in chains. As *Coscinodiscus* it appears, not spherical of course, but as flattened spheres and when it is viewed on the side view, as it is called, looks like discs.

As students of the *Bacillaria* are commonly observers of *Diatomes* merely, looking at the prepared plants or what they are called, the disc is a common form seen and *Coscinodiscus* becomes a disc-like form.

Two common forms appear in the spring when, or nearly when, the *Cyclotella* in fresh-water makes its appearance. These are the first to appear (*Nitzschia*) and commonly two or three days or a week or so after *Synedra*. These are both baccillar or rod-like forms. The *Nitzschia* are not so rod-like as the *Synedra*, but both are common the *Nitzschia* perhaps most common, and in still water, whilst the *Synedra* is in running water. *Nitzschia* appears in positions where the stratum is only slightly moist, as for instance on the green scum of flower-pots, which is made up of unsized clay and is therefore porous and holds the water readily. The form that occurs under this circumstance is a short rod, seeming like a disc that has been growing in one direction more than another, in fact an oval form. It was called by *Meneghini*, *Frustia viridula* and it was published, in 1844, in *Die Kiesdshaligen Bacillarian oder Diatomace* by *F. T. Kutz*ing. But it is now *Nitzschia frustulum*. It was called *Synedra frustulum* by *Kutz*ing.

We see how these *Synedra* and *Frustulia* and *Nitzschia* came to be the same. *Nitzschia frustulum* is extremely common as has been said on the porous red-clay flower-pots. It appears in this climate, Newark, N. J., in the

shade where the sun does not strike it. It is also very, very small, so that when examined with a quarter-inch objective, which magnifies about four hundred diameters, it can just be seen, and would not be observed at all were it not in constant motion, moving about like a little canoe or boat, first one way and then the other. It is also seen when living to be marked with one or two oil-spots in its interior. These are known as oil-spots or oil-dots and what they are is problematical. I think they are the representatives of ovaries. They are where the ova or germinial dots or spots appear. Although they are so small and it is, therefore, difficult to ascertain exactly what they are and what they form, I think that the ova, if they can be called so, appear there. On account of their being composed of oil-like substance, they appear (when examined by means of the microscope) when the Bacillarian is swimming around in the water. They are of a different (higher) refractive index, than is the surrounding water and appear bright.

This is the appearance of the Bacillarian. At first it is not so clearly seen for the oil globules are not formed. Subsequent thereto there appear in the cell-contents of the Bacillarian certain minute dots which one just sees to be active, rushing and pushing about in violent motion. These are oil-like also, although not so much so as the oil globules. Their presence and what they are have also caused wonder and why they are there has not been conceded, but I think they are anthozoa or what are so-called and are male organs. At least, (but how we know not), they impregnate the other oil-globes, and these being impregnated burst the shell of the Bacillarian and escape to find a new colony of Bacillarians.

This commonly takes place, in the spring, in this region. In other regions where there is not such a change of temperature from winter to summer, for it is this change which marks the existence of Bacillaria, it is true of

other organisms, higher still, that the impregnation may take place more than once a year. In fact, I noticed that the Bacillaria were more common in California than in this region, and therefore they multiply more commonly. In the tropics, they must be more common still, and as they there grow or multiply more rapidly, the accumulation of their dead shells must be greater. Infusorial deposits must be greater there also.

As the minute Nitzschias appear in spring as oval forms they grow to be bigger, but as they have begun to enlarge more in one diameter than in the other, they continue to grow in that manner and one diameter grows much more rapidly than the other. In this manner they became more and more rod-like, until the form is seen of a true *Synedra* with the longitudinal length several times as great as the transverse one.

How the other various forms of Bacillaria are formed can only be surmized for it cannot at present be seen how it takes place. But how a round form like *Coscindiscus* can change into a five or six-sided form and this into one four-sided, (*Amphitetras*) or a three-sided (*Triceratum*) or even a two-sided form (*Biddulphia*) can readily be seen. Already they are all placed in one genus, but there are forms that it is difficult to see how they came about. Time will unravel that seeming mystery, as it has other equally hard ones, and the evolution of the Bacillaria be made plain.

I wish to make plain so far as possible the synonymy of the Bacillaria for the study of those beautiful atomies should be made as easy and as pleasant as possible. It must be remembered that study is very different from observing and naming. Anyone can observe and name a thing but only one who spends time to observe can study the things he sees.

In the report on diatoms of H. M. S. "Valorous" which went on a cruise to Davis Straits in 1875, George Dixie

has the following (Proc. Roy. Soc., 1877, Vol xxx p. 227). Mr. Gwyn Jeffries, during the voyage of the "Valorous," collected by means of the towing net, in lat. $58^{\circ} 51' N.$, long. $34^{\circ} 18' W.$, a peculiar organism having the appearance of a small sponge. It was found to have a very wide range extending over some thousands of square miles. The general aspect of a specimen preserved in spirit is such that it might be readily mistaken for a sponge. These objects were submitted to Dr. Bowerbank and Mr. Carter, who both reported it to have the character of a sponge. The latter was more specific in his opinion, and pronounced it a Diatom, probably a *Synedra*. Before Mr. Carter's report, I had arrived at the same conclusion. The organism is of the genus *Synedra* and remarkable on account of the large proportion of celluloid matter which seems to connect the frustules in masses. The former may be compared to the sarcodes; the latter, to the spicules of the sponge, but there is a mere resemblance. It is further notable on account of the great length of the frustule as contrasted with their breadth.

The countless multitudes of this diatom, and of others of the same family, and the extent of sea over which they extended, are points of interest contributing directly as they do to the support of various smaller marine animals, and these in turn to larger forms, adding also to deposits taking place at various depths. I add a brief description of the *Synedra jeffreysii*: "Frustules greatly elongated, straight in front view linear, ends subcapitate no psue-nodule, in side view linear rectangular, striæ marginal. The total length varies from a ninth to a tenth of an inch, and the front has a diameter of 1-4000, the side view about 1-2500 of an inch. The striæ are 40 to 50 in a thousandth of an inch."

Now this form is common in the soundings which I have examined and which were brought home by Admiral Belknap in the U. S. S. "Tuscarora," showing that it is

cosmopolitan and showing also the opinions of naturalists to the species also. Both Dr. Bowerbank and Mr. Carter were inclined to make it a sponge from visual examination and not from physiological grounds. And here I will strongly urge the physiological ground for the definition of forms, for species are visual and forms are physiological. The physiological ground can be worked to an unlimitted extent if need be. The optical ground can be turned to a microscopical use in the case of minute organisms only, and therefore is unreliable. But I have already said this in other publications.

The optical appearance of the organism in question was a sponge and the physiological agreed for it could be only from the soundings. But it is my wish to point out here that on physiological grounds the organism was neither a diatom (although placed there understandingly) nor a sponge, but belonged to the order of *Protista*, organisms that have neither the properties of a plant (diatomacean or bacillarian), nor animal (sponge), but which live by means of matter which is absorbed into the mass not by a mouth but by a membrane of some substance which has the properties of cellulose but is not. It neither absorbs carbonic anhydride as plants do, nor nitrogen as Bacteria do (plants) ? or Fungi (plants also), Radiolaria (animals), or Spongidae, (animals also). By means of this membrane, it absorbs by diffusion, the silica from the hydrate of silica in the water and deposits it inside the membrane, and this it does as a Protistan and a plant (Bacillaria or Bacteria or Fungi) or animal (Radiolarian). So that the lower organisms are the same physiologically or optically and cannot be distinguished in any way.

Another fact : In all the soundings made by the "Valorous" and "Challenger" in the Pacific and Atlantic oceans, and also in the soundings brought home by the *Tuscarora*, as well as in gatherings containing living forms everywhere, the most common Bacillarian is the *Coscinodiscus*

radiatus of G. von Ehrenberg. But *Coscinodiscus radiatus* is a more recent form than *Coscinodiscus asteromphalus*, so that they must accordingly all be referred to that form.

Synedra jeffreysii is the same as *Synedra thalassiothrix* P.D.C. (1873. *Diatoms from the Arctic Sea*, p. 22. Pl. 4, Fig. 24). It includes the genus *Thalassiothrix*. This is found in the Mediteranean at Rimini and Fans, and at the Nicobar Islands. *Ethmodiscus* is but a form of *Coscinodiscus*, perhaps *C. asteromphalus*, and both of these *Coscinodiscus* and *Synedra jeffreysii* are common in the Pacific coast Infusorial stratum. *C. asteromphalus* also includes *C. craspedodiseus*, E. O'M. (Quar. Jour. Mic. Soc., Vol. XVII. p. 561), as well as *C. moseleyii*, E. O'M. (Jour. Lin. Soc. Lond., Vol. XV. p. 57, pl. 1, Fig. 6); and *C. arrapurensis* E. O'M. (Quat. Journ. Micro. Sci. 1877. p. 463); and *C. arapurensis*, E. O'M. (Var. nov. Cast. Chall 1886. p. 153, pl. 11. Fig. 4.) *C. centralis* C. G. E. (Var. nov. Cast. Chall. 1886. p. 155, pl. 11. Fig. 3.); *C. minificus* F. C. (1886. Chall. p. 154, pl. 11. Fig. 6,) and *C. papuanus* F. C. (1886. Chall. p. 154. pl. III, Fig. 8).

In his preliminary notes on the nature of the sea bottom pronounced by the soundings of H. M. S. "Challenger" during her cruise in the 'Southern Sea' in the early part of the year 1874 (Proc. Roy. Soc. Nov. 26, 1874, p. 47).

Professor C. Wyville Thomson says: "On the 11th of February, lat. $60^{\circ} 52' S.$, long. $80^{\circ} 20' E.$, and on March 3d lat. $53^{\circ} 55' S.$, long. $108^{\circ} 35' E.$, the soundings came up filled with a fine cream-colored paste, which scarcely effervesced with acid, and discolored into a very light impalpable white powder. This, when examined under the microscope, was found to consist entirely of the frustules of diatoms, some of which were wonderfully perfect in all the details of their ornament, and many of them were broken up. The species of diatoms entering into this deposit have not yet been worked up but they appeared to be referable chiefly to the genera *Fragillaria* *Coscin-*

odiscus, *Chætoceros*, *Asteromphalus*, and *Dichtyotha*, with fragments of separated rods of a singular organism with which we were unacquainted, and which made up a large proportion of the finer matter of this deposit. Mixed with the diatoms there were a few small *Globigerinæ*, some of the tests and spicules of Radiolarians, and some sand particles; but these foreign bodies were in too small proportion to affect the formation as consisting practically of diatoms alone. On the 4th of February in lat. $52^{\circ} 29'$ S., long. $71^{\circ} 36'$ E., a little to the north of the Heard Islands, the tow-net, in dredging a few fathoms below the surface, had come up nearly filled with a pale yellow gelatinous mass. This was found to consist entirely of diatoms of the same species as that found at the bottom. By far the most abundant was a little bundle of silicious rods (pl. III, Fig. 5.) fastened together loosely at one end separating from one another at the other end, and the whole bundle loosely twisted into a spindle. The rods are hollow, and contain the characteristic endochrome of the *Diatomaceæ*. These were *Synedra jeffreysii*, and *S. thalassiotrix* Cleve.

Synedra jeffreysii and *Coscinodiscus asteromphalus* are cosmopolitan, be it at the equator or at the poles; and I think they can be said to have been derived from *Synedra ulna* and *Melosira varians* in fresh-water. *Synedra jeffreysii* is *Synedra fasciculata*, C. A. A., which is a *Diatoma fasciculata* C. A. A., and is found everywhere in the ocean. I lately have it from lat. 60° N. in Alaska, being engaged in working up the *Bacillaria* from the far north, Alaska, in lat. 60° N., for the U. S. Experiment Station, Agricultural College, Brookings, S. D. These were sent to me by Mr. D. A. Saunders, botanist and entomologist and they show that *Synedra fasciculata*, C. A. A., is an extremely cosmopolitan form.

WANTED.—To exchange diatomaceous earth. C. W. Smiley.

BIOLOGICAL NOTES.**L. H. PANZEL.**

HYBRID CITRUS.—Mr. H. J. Weber, of the U. S. Department of Agriculture, presented some interesting facts concerning Citrus hybridization caused by polyembryony at a recent meeting of the Society of Plant Morphology. He has shown from many observations and comparisons of the foliage characteristics of the hybrids that where two or three seedlings were developed from a single seed they not infrequently showed marks of foliage differences. It is well-known that most species of the genus Citrus are commonly polyembryonic. A single seed of a common orange has been known to produce as high as thirteen seedlings. The adventive embryos develop directly from the mother tissue and the writer says, "we should not expect to show any of the characteristics of the male parent. This was the conclusion reached by Mr. Swingle, and the writer jointly in discussing the matter several years ago, and the development of the hybrids has now shown this to be the case. In several instances in hybrids of *Citrus aurantium*, which has unifoliolate leaves, with *C. trifoliata*, which has trifoliolate leaves, where the former was used as a female parent, two or three seedlings have been produced from the same seed; one of which had trifoliolate leaves and the others strictly unifoliolate leaves exactly like those of the mother parent. In such cases it is evident that the trifoliolate seedling inherits this character from the male parent and that the embryo from which it grew was developed from the egg cell proper. The other seedlings in such cases, having unifoliolate leaves like the mother parent, are doubtless developed from the so-called adventive embryos."

TUBERCULAR INFECTION.—The Messrs. Lannelonge and Achard have made a series of experiments to determine the different channels through which animals may take

tuberculosis, and in many cases it is in the neighborhood of the point of inoculation that the wound has taken effect. They conclude that tuberculosis does not act identically as other infectious diseases especially in regard to severe suppurations. They show that blood infection in tuberculous animals is rare.—"Vet. Jour. 1:7."

RED COLOR OF PLANTS.—Miss F. G. Smith in a paper on the distribution of red color in the vegetative part of the New England flora (Science N. S. 11:301), calls attention to the various more or less conflicting views in reference to the red color in certain parts of plants. Miss Smith comes to the conclusion that there are several different reasons for the red color or else it has some significance to which we as yet have no clue.

HETEROECIOUS RUSTS.—H. Klebahn (Zeitsch. f. Pflanzk) 1899:9) who has experimented with heteroecious rusts finds that the *Melampsora populina* (Jacq. Lev), which according to Hardy is connected with *Caeoma laricis* is not the same as the *Melampsora*, on the *Populus tremula*. There appears also to be several specialized forms of *Puccinia caricis*. One of these species produces its aecidia spores upon *Ribes*. The results of Klebahn as well as those of Ericksson and other investigators on the relations existing between the teleuto and aecidium stages of our cereal rusts show that many of our species of rust can only be determined in light of cultural experiments.

APPLE CANKER.—Wendel Paddock (Bull. N. Y. Agri. Exp. Sta., 163:) who has conducted some experiments with Apple canker comes to the conclusion that it is caused by *Sphaeropsis malorum*, a fungus which causes the black rot of apple, pear, and quince fruits. He made cultures of the fungus in agar-agar, and with these cultures produced the disease.

UDDER BACTERIA.—Archibald R. Ward (Bull. Cornell Univ. Agri. Exp. Station, 178:) who has made a study of

the lactiferous ducts of cows found that nineteen udders examined harbor bacteria throughout their whole extent. Milk when secreted by the glands of the healthy udder is sterile, but it may soon become infected by the bacteria which are normally present in the smaller milk ducts of the udder. The bacteria so far found are not injurious. Certain "dairy bacteria" in milk may be explained on this constant contamination.

Notes on Microscopy.

F. SHILLINGTON SCALES, F.R.M.S.

THE QUEKETT MICROSCOPICAL CLUB.—The good work done for a generation of microscopists by the Quekett Club, the very name of which has a grateful sound in the ears of all ardent lovers of the microscope, requires no mention here. There are several late things of interest amongst them being a paper by Mr. C. D. Soar on a water mite that he believes to be a new species, and which he proposes to name *Atax taverneri*, and another paper by Mr. R. T. Lewis on some Australian ticks, each being illustrated by a well-engraved plate. Dr. M. C. Cooke, writes on "Early Memories of the Q. M. C." He traces the intimate connection that existed between the Club and Science-Gossip. Mr. Cooke calls attention to the work done by the late Robert Hardwicke as a publisher of scientific books at his house in Piccadilly, from whence issued the "Popular Science Review," and the third edition of Sowerby's "English Botany." Mr. Cooke was a daily visitor to the little shop in Piccadilly, and suggested that there was a good opening for a cheap monthly magazine devoted to natural history and microscopy, with facilities for exchanges and copious notes and queries. The idea was entertained eagerly, and Science-Gossip appeared January 1st, 1865, and became at once a success; in fact, had no competitor. Once a week, Mr. Cooke, Mr. Kettringham, and his friend, Mr. W. M. Bywater, used to

meet at a house in Hanover Square and pursue together their microscopical studies. On May 1st, 1865, a notice was published, suggesting the formation of an amateur microscopical society that would cover ground untouched by the Royal Microscopical Society. For this reason the subscription was made as small as possible, and the club itself was formed July 7, 1865. Since then the Club has done good work for amateur microscopy, and almost as much for microscopy in general, and it still flourishes.

W. WATSON'S NEW $\frac{1}{2}$ INCH HOLOSCOPIC OBJECTIVE.—Two new achromatic objectives by Messers. Watson & Sons, were constructed on a new principle, having similar corrections to the apochromatic lenses, and, like them, requiring to be used with compensating or over-corrected eyepieces for their proper correction. This enterprising firm has now put out a lens which we can only describe as a remarkable one. It is a half-inch of no less N. A. than .65, which is equivalent to the very high optical index of 31.5. Its spherical and chromatic corrections approximate more closely than we would have believed possible to those of the apochromatics. The finest dry lens at present made is considered to be Zeiss's apochromatic half-inch, and Messrs. Watson's lens has the same power and the same aperture. This in itself is in its way a distinct achievement, as we know of only one other similar lens which exceeds this aperture. But a very careful comparison between the new holoscopic lens and the apochromatic half-inch shows that even on the most difficult and critical tests the achromatic is hardly surpassed by the apochromatic lens. In spherical correction and in definition there is really little to choose between them; but the achromatic lens, as is to be expected, shows, on critical and suitable tests, a slight amount of outstanding color that is absent in the apochromatic. The objective is corrected for the 250 mm. (10") tube, and bears a 27 compensating eyepiece most satisfactorily. The price is \$17.50.

American Postal Microscopical Club.

NOTES ON SOME OF THE SLIDES.

Artificial Onyx.—It is not commonly known that nearly all of the onyx used in the arts is colored by artificial means; the original color of the agate being usually a white, or varying shades of gray and white, the bands of color representing varying degrees of density, or, more properly, permeability; which bands are supposed to be produced by different degrees of rapidity with which the formation takes place, though doubtless many other causes, such as temperature, pressure, etc., contribute to produce the result. Advantage is taken of this structure to effect the coloring which is done in the case of black onyx by immersing the stone in a mixture of honey and water, where it remains several weeks at a high temperature. It is then boiled in sulphuric acid, which carbonates the saccharinous matter which has penetrated the stone, thus rendering certain bands an intense black, while others, remaining unaffected, appear by contrast, of a pure white. Various colorations may be produced by different chemical reactions. What is the difference in the molecular structure of the two bands of equal thickness, one of which is penetrated by the honey solution to the depth of an inch or more, while the other, of the same atomic elements, and apparently of the same hardness, remains absolutely unaffected? Agates and chalcedony have been used from the most ancient times as articles of adornment and jewelry. The parti-colored bands of the onyx furnished suitable media from which to produce fine effects in relief and intaglio engraving, in many instances several bands of different colors being utilized for this purpose. In modern times the skill of the glass-maker has largely supplemented that of the engraver.—J. D. MALLONEE.

Section of Jade.—Jade is not a mineral species, but its name is given to various minerals having a similar characteristic physical structure which makes the material exceedingly tough and therefore well adapted for the manu-

faute of implements, images, etc. This fact was noted and taken advantage of by the aboriginal races of all countries where it is found, and among whom it was always held in high estimation. This specimen from New Zealand, is dark green in color and quite hard. Mineralogically it is probably an amphibole related to actinolite, but it may be jadeite. As seen in the section by polarized light, it consists of a mass of interlacing crystalline fibers or plates, which is the characteristic structure of jade, and which gives it the toughness mentioned above.

Some jads have been found to consist of zoizite and epidote, while the softer varieties (coming principally from China under the name of nephrite) are merely serpentine. In color it is almost always of some shade of green. It is doubtful if any of the true hard varieties occur in America. Some of the serpentines are quite as well entitled to the name as that from China, but the hard variety, almost identical in color and structure with this specimen, which is found in the form of implements on the Pacific coast principally of Alaska, has been brought from Siberia via Behring Sea.—F. J. KEELEY.

Some months ago, a friend sent to me, as a curious example of oriental duplicity, a broken ring made of fictitious jade. The ring, which was about as thick as one's little finger and nearly four inches across, might have served in arranging drapery or for other ornamental purposes. It had an opalescent appearance, without any distinctly green color. It was very hard and tough, with a conspicuous fibrous structure. It had been brought from China as a true jade ornament, and it was decided to be by two expert judges whose opinion was supposed to be final. Afterward it was accidentally broken, and the appearance of the fracture satisfied everyone that it was an artificial glass imitation. The most important point is the loss of confidence resulting from its having deceived the experts; and perhaps, in addition, the conclusion that if you want to be sure of an object of art—it might be well to break it first.—R. H. WARD.

Preparing Isolated Slide.—This slide displays the greatly elongated branches of the cells better than when seen in situ within the tissue of the spinal cord in ordinary preparations. It was made by rubbing the end of a segment of the spinal cord of an ox across the slide, and then staining in haematoxylin, for 24 hours, all that has adhered to the slide. It was then washed with alcohol, dehydrated, cleaned with olive oil, and mounted in balsam. Besides the branching of the nerve cells, there may be seen innumerable threads forming a dense tangle, in whose meshes are many dark granules. The threads and granules, together with a somewhat undifferentiated fluid-like substance seem to form the intercellular neuroglea of the spinal cord. The threads are not unlike the slender branches of the nerve-cells, and the granules somewhat resemble their nuclei, and it has been suggested by Dr. Carlier, of the University of Edinburgh, that they are the remnants of degenerate cells. The best group of cells may be seen by placing the slide on the stage with the club label to the left, and searching near the edge of the cover-glass at the spot here indicated by a cross.—B. L. SEAWELL.

A Mount of Putrefactive Bacteria.—This specimen was dried from water spontaneously, without heat, upon the cover-glass, and then immersed for several hours in a mordant composed of tannin thirty grains, anilin oil twelve drops and alcohol one fluid ounce rendered slightly alkaline with sodic hydrate; and then, after soaking in water for five minutes to remove excess of the mordant, it was stained with neutral solution of rosanilin or fuchsin. The freshness of this specimen which was prepared in 1891 shows the value of mordanting for staining bacteria. The method does not distort and shrink the forms as passing through the flame does, the alcohol and tannin fixing the bacteria in more natural shape than is accomplished by other methods. The spiral forms showing flagella easily are spirillum undula; the straight rods are bacillus ulnus, which also show the flagella under a good 1-10th or 1-12th immersion objective. The dendritic forms on this slide are due to the tannin, and not to the bacteria; they may be avoided, but are

sometimes developed by long mordanting. A slide showing them was purposely chosen as a warning to others using the method.—AMOS P. BROWN.

Locating Objects on the Slide.—The location of the special group of cells as mentioned by Prof. Seawell, and indicated by his diagram in the note book, and as seen on the slides, can be best described as at "7:30 (or 7½) o'clock," or at "South West," if one prefers the compass method. For full identification, including the radial distance from the center, an adept would write it at "loc. 7:30 rad. 8," or "loc. S. W., rad. 8;" or in recording frequently or tabulating, the contractions for "location" and "radius" would be omitted, and the figures only stated, as "7:30, 8," or "S. W., 8," the meaning of the figures being indicated by their position where they could mean nothing else. If anyone who has frequent occasion to refer to slides, and who has not used this method of location, will do himself the favor of getting it thoroughly in mind and hand, so as to give it a fair trial in practice, and find how convenient and practical it is for cases not requiring the Maltwood finder, he will be likely to wonder why everyone does not use it. These precautions are to be observed :

(1). Decide whether you will record the actual location as seen with a simple lens, or the apparent location as seen (inverted) in the compound microscope, and always follow the same rule; and specify which you mean, at least in the few doubtful and difficult cases, when offering records to those who do not know your habit. The latter method, recording as it always looks in the microscope, seems to me simplest and most rapid, and least liable to mistake, as all observations and readings are direct and without a constant allowance for reversal; you must, however, allow for reversal of your record, when looking at the slide with the naked eye or under a simple microscope. In the slide under consideration, the two most notable regions happen to be just opposite each other, one in the mount at 7:30, but appearing in the microscope at 1:30, and the other exactly the reverse. (2). In a specimen considerably smaller than the cover-glass, especially if eccentric to it, it may be best

to state, to those not knowing your habit, whether the specimen or the cover is measured; thus a certain point of a section may be at 9, 3 of the section but at 3, 1 of the circle (cover-glass or ring). (3). If unable to find what is desired, try a reversal of one or both of the above rules, and see if it has been recorded in that way.—R. H. WARD.

Mounting Fish Scales.—I used to pay 50c. each for unstained mounts of fish scales, but have found a new way of making them to suit my taste much better than "store slides." Procure a piece of the skin of a fish (sole), and macerate in liquor potassæ until the skin is quite soft. The scales can then be separated and washed in several changes of water, dehydrated in alcohol, stained in alcoholic solution of eosin, washed in alcohol, cleared in xylol, and mounted in xylol balsam. This makes a very fine object for polariscope, easily and cheaply made, and finer and better than nine-tenths of those purchased.—THOMAS J. BRAY.

Insects Mounted in Balsam, from Alcohol.—The specimens on this slide, while rather poorly mounted, show well the changes mentioned. Had they been put into carbolic acid (pure and liquified by heat) instead of into alcohol, they would have been cleared and made transparent while remaining soft and flexible, and could with the greatest ease have been arranged so as to display all their external members for convenient examination. The specimen, of which a photograph (by a 2-inch objective) has been made, was prepared by this method.—C. M. V.

MICROSCOPICAL SOCIETIES.

Quekett Microscopical Club.—The 376 meeting was held on March 16, at 20, Hanover Square, W. ; Mr. George Massee, F. L. S., President in the chair. After the usual formal business, Mr. H. Morland exhibited and described a simple device for storing and protecting from dust selected diatoms fixed on cover-glasses until they were ready for mounting. A paper on "The Tracheæ of Insects, &c." by Mr. A. A. Merlin, was, in the author's absence, read by the secretary. Mr. Merlin contends that the well-known

spiral deposit does not consist of one long, continuous fibre, as usually stated in books, but in reality it is made up of comparatively short pieces, rarely extending unbroken beyond a few turns round the tube. Mr. Michael doubted if this observation was new, and thought the correct structure, which was as stated by Mr. Merlin, would be found described in the more modern German works—such as, for instance, Lang's "Comparative Anatomy." Mr. Hughes also quoted some authorities to the same effect. Mr. Hilton thought the very term "spiral fibre" a misnomer. In some cases, at least, it could be made to disappear on pressure, and in his view the appearance was produced by folding, like the extending bellows of a camera, and was obliterated in the same way by being stretched. Mr. J. T. Holder then gave an exhibition with the lantern, projecting some 130 beautiful photographs on the screen. The subjects comprised vegetable and animal histology, diatoms, radiolaria, and foraminifera, &c., and were all his own work. A very cordial vote of thanks to Mr. Holder was moved by the President and carried by acclamation. The deaths of Mr. J. W. Bailey, Mr. W. Goodwin, and Amos Topping, the well-known mounter, were referred to.

NEW PUBLICATIONS.

Manual of Bacteriology.—Young J. Pentland, Edinburgh and London. p. xviii 564. Fig. 126. New York, MacMillan Co. 1899.

The fact that a second edition of Muir and Ritchie's *Manual of Bacteriology* has appeared in two years speaks well for the work. It is essentially a work for practitioners and students as it deals only with those bacteria and other low organisms, *Amœba* and *Plasmodia* connected with the diseases of man. The work only deals with the pathogenic bacteria of man and only incidentally touches upon those occurring in lower animals when the same organism occurs in both. It is to be regretted that the authors did not include the other animal bacterial parasites. It would have added greatly to this excellent volume. The general ac-

count of the morphology and biology of bacteria is excellent although very much condensed. They hold it as extremely problematical that arthrosporous bacteria exist among the lower forms. It is probably true that Hueppe and DeBary did not sufficiently limit the existence of arthrosores among bacteria, but some forms undoubtedly have arthrosores. According to the authors, bacteria are divided into the lower bacteria which include cocci, bacilli and spirilli. The higher bacteria include the thread-like forms more or less septate, and oftentimes surrounded by a sheath. They adopt this classification because our knowledge is too limited to allow a really natural arrangement. While it is true that our knowledge of many forms is imperfect, it seems to the reviewer that the system of Migula is preferable to the artificial groups established by Flugge Muir and Ritchie, and others. The higher group of bacteria of the authors includes undoubted fungi and should be so regarded e. g. the *Streptothrix actinomyces*. It is to be regretted that the authors failed to give due recognition to the American work. They have devoted considerable space to technique, and this matter could not have been arranged better. The part dealing with pathogenic organisms is excellent, the literature has been thoroughly sifted and the subject matter has been presented admirably. Aside from these few short-comings it is one of our best works on bacteriology. The illustrations are a special feature of the work and we can most heartily commend it to all who desire to pursue the subject.—L. H. P.

Lessons in Botany.—Prof G. E. Atkinson. Henry Holt and Co., New York, p xv. 365. fig. 276.

This new text book in botany, is an abbreviated and much simplified edition of his elementary botany. Much of the work has been re-written and is therefore better adapted for secondary schools. The work is divided into three parts. The first deals with physiology, the second the morphology and life history of representative flowering plants, the third ecology. Laboratory exercises are arranged with each topic in parts one and two. Excellent figures accompany the various topics. A discussion of the homologies

of sporophyte and gametophyte in the vascular cryptogams, phænogams and thallophytes is entirely omitted and rightly too as it is a subject too difficult for a beginner to understand. The chief point for a beginner in botany is to become interested in plants. The illustrations are excellent and the treatment of the subject matter is good. The work should commend itself to a large number of secondary schools.—L. H. P.

Chats About the Microscope.—By Henry C. Shelley. Scientific Press, Ltd. Illustrated. A little book intended to enlist the interest of aimless pedestrians in country places who sacrifice the pleasure and instructions contained in every mossy bank, every darkling pool—the happy hunting-ground freely accessible to all who will but avail themselves of the key to Nature's precious casket. The book is but a slender introduction to pond life, diatoms, foraminifera, and a few other kindred subjects; lacking the sequence necessary as a basis of pure scientific study, it is better adapted as a guide in using the microscope incidentally as a source of innocent amusement. The illustrations are not very attractive—the "porous cells of mosses," for example, figured on p. 60, look as stiff and mechanical as if intended as a working drawing for the making of bookshelves.—*Knowledge*.

MICROSCOPICAL NOTES.

VERMIN.—The use of mercury pellets is recommended to free slide boxes and store cabinets from mites, psoci, etc., and also to collect any particles of dust which may gain entrance. A few small pellets of mercury, placed free in the bottom, will, by the movement of the box or drawer, be caused to roll to and fro and accomplish the desired end.

DUST.—Bell covers, for protecting preparations from dust, may be made by cementing a small handle or cork to the centre of the convex side of watch glasses.



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CONTENTS.

Advice to Young People who wish to Hunt Diatoms. Edwards....	151-155
The Study of Little Things. Edwards.....	155-156
Report on Microscopy to the Medico-Legal Society. White....	156-159
The Microscope in the Drug Store.....	159-164
Bacteriological Diagnosis in Kalamazoo. Crane.....	164-166
BIOLOGICAL NOTES —PAMMEL.—Lichens; Crown-gall; Chromatophores and Nuclei; Anatomical Atlas; Plant Diseases; Ropy Milk; Bacillus; Prodigiosus; Rancid Butter; Lactic Acid Ferments and Cheese Ripening.....	167-170
NOTES BY J. H. COOKE.—Preparation of Marine Worms; Microphotography; Staining Bones; New Lamp; Screen; Focussing; Opaque Objects; Plates.....	171-174
NOTES BY SHILLINGTON SCALES.—Illumination.....	174-177
MISCELLANEOUS NOTES.—Society Screw.....	177-178
NEW PUBLICATIONS.—Acetylene; Plants, Text-book of Botany..	178-179

Advice to Young People Who Wish to Hunt Diatoms.

ARTHUR M. EDWARDS, M.D., F.L.S.

Now the time has come in the Middle States, to be out of doors, and it is just beginning in Canada. On the Pacific coast it is always. The young people with microscopes, one-half inch objectives, want to know how to hunt for Diatoms. I hope they will get as much satisfaction and stimulus from it as I did over forty years ago.

The Diatoms are not what we call Diatomaceæ or Bäcillaria, for that is the older name given to them by Agardh and Kutzning. The latter studied them and published them as living things. Ehrenberg, who gained so great a notoriety, studied them and published his big

books about them only as dead shells, the Diatoms in fact. But as we are going to get them living as Bacillaria, we are also going to procure them as dead shells, (Diatoms). Diatomaceæ were supposed to be vegetables, the relics of the "animalcules" of all the older naturalists. Diatoms in common parlance is the term used for the prepared shells of Diatomaceæ. Bacillaria are what are known as Protista, that is to say organisms which occupy a place in nature, as described by man, between the animal and the vegetable.

The Bacillaria are minute and seemingly unicellular, having but one cavity. But the cell contents are divided into two sections. However, they are taken as one-celled or unicellular organisms. Begining at the outside they are made up of an extremely thin coat of a substance which has not been analyzed as yet, but seems to be protoplasm. Then comes the shell or lorica. This is composed of hard matter which is very soluble in fresh-water and sometimes contains silica or aluminium silicate. When they are cleaned or when found as fossils in the earth, the matter is siliceous, like clay, and this is what is known as Diatom, so that diatoms are the shells of Bacillaria. We talk about hunting for dead diatoms or for living Bacillaria.

Within the shell are the cell contents, which have not been analyzed as yet. But the main mass consists of large quantities of endochrome. This is olive-colored matter and can be distinguished when the Bacillaria are viewed with the unassisted eye. The confervæ are bright green water plants but the Bacillaria are yellowish. When viewed by means of the microscope the endochrome is seen to occupy the outside of the cell contents but within the shell it occupies two portions one of which is situated on the inside of each valve. In Spring, in this climate, when the Bacillaria appear they have an endochrome, and it is scattered over the inside of the endochrome plates,—

certain minute and numerous dots or cells. They are of a different refractive index from the surrounding protoplasm and of oily consistence. They are in trembling motion and seem to be anthozoa or male organs. After a time they come to a rest or to disappear or they appear quiescent. Before they do so there appear certain larger bodies which instead of being called dots are known as oil globules. They are much larger than the anthozoa and seem to be made up of a dense oily substance, but like the anthozoa have no limiting membrane. They occur mostly only as two, one in each half of the Bacillarian. They are also at rest. They seem to be ova or female organs. This is the composition of a full individual of a Bacillarian and is all that we know positively concerning them.

Let us now go after the Bacillaria or Diatom-hunting as it is called. We provide ourselves with some two-ounce corked bottles with large open mouths. We can take one or more with us, but an enthusiast will have several, one or more in each pocket. We will take a lunch, for we are going a long distance and will be away a long time, all day perhaps. We can take a pocket microscope with us. I mean a compound microscope magnifying about fifty or a hundred diameters, such as can be bought for a couple of dollars. Of course the pocket lens will always be present, for everybody should have a pocket lens always with his knife and purse. I should not feel I was dressed without my pocket lens.

Being equipped with stout old shoes, we travel along a road but soon we see a mass of water that looks promising. We get over the farmer's fence into his grounds and go for it. If weather has been dry, we see green scum on the earth. This may consist of *Protococcus* and diatoms or it may contain *Protococcus* alone. At all events the forms of Bacillaria are smallest of the small and cannot be studied by the tyro. But to one advanced in the

use of a microscope the gathering will yield good results. *Nitzschia frustulum*, which Kutzing described, will be the first gathering. Put it in parafine paper—waxed paper it is called—to keep it from drying up, and you may take it along.

Next notice the pools which have been left by the rain. Here you will not get *Bacillaria* unless the pool has stood a long time. But we dip a bottle full from the green or yellowish green scum on the surface of the water, for it may yield several forms or "species" of *Navicula*. You may see on the rocks or mud just beneath the water's edge, a dark-green mass of matter. Here you will most certainly get *Synedra*, or *Achanthidium*, or even *Melosira*, or other things. Get a dip there. On the stream that flows from there you will get *confervula*, known by the brilliant green color, covered with the same and perhaps *Epithemia* and *Coccconeis*. On a larger pool, or a pond or lake, the olive-green or yellowish-green scum is rich in *Bacillaria* and you will get all that you can study. So fill your bottles and spend many an hour over it when you get home to your compound microscope. So much for recent fresh-water *Bacillaria*.

Now for marine forms. Along the shore, at going down of the tide there are pools left which will yield *Grammatophora* or *Biddulphia* or *Melosira* or *Schizonema*. In the scum that collects on the sand you may get *Epithemia marina* as it is called by A. S. Donkin. But marine or fresh-water is the same and *Epithema jurgensii*, C. A. A., must be the name. Algae although they are beautiful and will yield hours of experience to those who study them, we cannot get now for the algae themselves but we get them for the *Bacillaria* which cover them in countless millions on every rock and pile where the sea goes.

Fossil *Bacillaria* are more difficult to collect and study, but if you have the opportunity you may collect any light-colored and light-weight earth for them. Some

are dark, peat will often yield nice Bacillaria. But do not despair, try and try again. Out of one hundred gatherings for fossil Bacillaria perhaps fifty will yield good results. The other fifty is sand, fine or coarse, mud, and clay—most common of all.

The Study of Little Things.

ARTHUR M. EDWARDS, M. D.

I was reminded of the difficulty of studying the Bacillaria aside from viewing the Diatom shells by what I read in Dr. M. C. Cooke's Introduction to the Study of the Fungi where he says that "the only safe course in the study of Fungi or of any other of the multitudinous organisms, whether animal or vegetable, with which the earth teems, is to proceed step by step from the general to the particular by a systematic sequence. In a few cases it may be possible by reference to figures, or from incidental circumstances to attach a name with some accuracy, but such an act is of no service—it touches nothing, it avails nothing, it is only a sham, a delusion and a snare. The only road to knowledge is a rough one, but it must be traversed, and all its difficulties surmounted; there can be no creeping upwards by a by-path, for all the by-paths end at a precipice. The most we can do is to tread firmly, walk circumspectly and look upwards. The study of Fungi is not an easy one, and cannot be got over empirically, but with application and perseverance the difficulties which seemed at first appalling become less so at every step." And it is so with learning anything natural or artificial? We think we know everything but soon we know that we know nothing. We learn by unlearning. We know by learning how much there is to learn. Let us have patience with those who think they know anything and help them to learn the little there is to know. So Bacillaria are not learned by learning the names that have been given to them, for those are merely passing things.

We may call anything a Pinnularia but that does not prove it is not a Navicula, and if we know it as *Navicula viridis* that does not tell us all there is about it. No time is misspent in studying anything. We study evil to know what is to gain. So studying the Bacillaria we learn what there is to gain about them and others. We study the life of Protista to learn what is the life of man. We study the Bacillaria not merely to learn what they are called, and to study them a great many hours must be spent using the best optical instruments for viewing them under various modes of vision and also we must use the knowledge acquired in various departments of science. The student of Bacillaria must be a mathematician, a chemist, a zoologist and a botanist, and last of all a geologist, to understand the various phases of life which they present. And to study the Bacillaria we must STUDY them not merely view them a few times as beautiful things but as pieces of the framework of nature. That is to say, we must spend hours and days and weeks and months at one object, *Navicula viridis* for instance, and with the best objectives that can be obtained. So I say that life is short in which to study the Bacillaria and he knows most about them who has thus studied through hours of patient watching and constant viewing. Do not then condemn the student of the Bacillaria, the hunter of diatoms, the counter of lines on an angulata, for he is the student of the little things, the minute atomies.

Report of Moses C. White, M. D., Microscopist,

To the Medico-Legal Society.

In reviewing the progress of microscopic research for medico-legal purposes, the past year, it is interesting to notice, first, improvements in the microscope itself. Although the microscopic objective, by the application of the Jena optical glass, has attained almost an ideal perfection for

resolving fine lines and details of infinitely small objects when seen in the centre of the field of view, still the curvature of the field, want of flatness, remains about the same as it was at the great battle of the experts, Dr. Woodward and Dr. Treadwell, at the Hayden trial in New Haven, in 1879.

Blood corpuscles seen in the centre of the field are still seen more sharply defined than those in the border of the field, while those seen in the border of the field are larger, less distinctly defined, and the dark ring on the border is thicker, allowing less accurate measurement than corpuscles in the centre of the field. As yet opticians seem to regard this as an imperfection almost insurmountable. The same difficulty occurs in the use of the microscope to project images of small objects on the screen.

But during the last few months, Spencer of Buffalo, has constructed eyepieces for the microscope that considerably obviate this defect and flatten the field. For several years, Zeiss, Leitz and Reichart have made compensation eye-pieces which greatly improve the definition of the objective in the centre of the field. Zeiss has at length, during the past year, made other improvements in two new forms of eyepieces. Watson & Son's, of London, noting that the color correction and spherical aberration of no two objectives are exactly alike, has made from the Jena glass, by new formulæ, a new eyepiece, adjustable to correct defects in different eyepieces. Certainly the new eye-piece gives a wonderfully clear and sharp definition and at the same time comes very near to giving a flat field and sharp definition in the centre and in the borders of the field at the same time.

During the past year also, Reichert of Vienna, has undertaken researches and experiments to greatly improve low power objectives after a plan introduced by the writer in his mammoth microscopic objective 20 millimeter focus with aperture 0.95 N.A., made at his order in July, 1898.

In a recent trial at Middletown, Conn., in the case of the State vs. Hough, for the murder of Chadwick in July last, the microscope furnished important evidence. A red stain on a stone, found at the scene of the homicide, was shown by the microscope to be covered with corpuscles in all respects similar to those of human blood, while mingled with the blood corpuscles were a few hairs like the hair on the murdered man. Both these discoveries, and the coincidences of the two, gave convincing evidence that the stone in question had been used to make certain scalp wounds on the head of the deceased.

Although Prof. Ewell, *Medico-Legal Journal*, Vol. X, page 201, has questioned the possibility of deciding that any hairs examined, or blood corpuscles recovered from a stain, are human, yet when blood corpuscles exactly like those of a man and hair similar to those of a man are found in the same stain it is hard to doubt that both are human. Thus, notwithstanding possible doubt in some cases, the value of the microscope in medico-legal cases is clearly demonstrated. The use of the microscope for the identification of crystals of arsenious acid, (white arsenic,) though not giving absolute proof, as shown in a recent case in New Jersey, continues to be used as an important aid in diagnosis in cases of poisoning. In the case of State of Connecticut vs. Mrs. Anderson, charged with the murder of her husband by administering rough on rats in coffee, where he died in twelve hours after taking the fatal dose, several hens died in the yard where he vomited. In the crop of one of these hens an octagonal crystal having all the appearance of arsenic was discovered and identified by the microscope; and chemical analysis confirmed the diagnosis given by the microscope. In the body, stomach, liver and kidneys of the murdered man arsenic was obtained by chemical analysis, and crystals obtained by Reinsch's test where shown by the microscope to have the octahedral form of arsenious acid.

Thus the microscope, though not alone sufficient to prove the presence of arsenic, adds an important link to the chain of testimony which proves the presence of arsenic in case of poisoning.—*Med. Leg. Jour.*

The Microscope in the Drug Shop.

To the pharmacist who is so in something more than a name, the microscope is perhaps the most useful scientific instrument which can find a place in the shop. Too frequently its aid is not requisitioned, even by the possessor of one, and the cause is in many cases due to it being kept carefully locked up in its cabinet, out of reach of the inquisitive apprentice. If, instead of being so carefully preserved, a moderate-priced instrument were placed under a bell glass, and always had attached to it a double nose-piece, a half-inch and a sixth-inch objective, its true value would be soon appreciated. The value of it is not the amount of money it costs, but the amount of usefulness which can be got out of it. The amount of information which may be obtained by submitting all doubtful substances, and also many substances of good repute, to the scrutiny of the microscope is astonishing. It will often solve the strangest problems in the most unexpected way. Quite recently several bottles were returned containing liquids and deposits which were said to have formed in each. The said deposits were quite foreign to the original contents of the bottles. A microscopical examination proved the sediments in the different bottles to be absolutely identical in character and certainly of a common origin. The fact led to inquiries, which proved that the sediment had been found in the bottle only, and in some unexplained way had been distributed among the other bottles by a servant. At the dispensing counter the microscope should, and in the hands of resourceful pharmacists does, frequently give good service. To place on a glass

slip the deposit which has formed in a mixture and ascertain whether it is amorphous (perhaps mucilaginous) or crystalline is but the work of a few minutes, and information is gained as to the chemical incompatibility or the mere precipitation of inert matter of vegetable origin. Although the microscope may fail in some instances to solve the problem forthwith, yet it very rarely happens that it does not give speedy assistance in indicating the direction whence the final solution will come. On one occasion a parcel of citrate of iron and quinine failed to yield a bright solution with water. The usual causes of cloudiness were investigated without avail. A second lot was obtained from the manufacturers, but it turned out equally bad, and the makers could not give any explanation; they contended that their methods were such as they had always adopted. On submitting the carefully collected deposit to the microscope it was seen to consist of ordinary dust and minute fragments of straw. The manufacturers were then able to trace the source of the trouble to a defect in the partition, between the room in which the drug was put into bottles, and the contiguous room which was used for packing purposes. Doubts sometimes arise as to the correct dispensing of medicines, and the microscope will be found of great use in helping to determine the composition of mixed powders and pills.

It is so common for the pharmacist to buy his drugs in the form of powder that one would think the microscope would be indispensable if he is to be, as he ought to be, surety for the drugs he sells. The wholesale druggists, of this country are, as a class, above suspicion, and upon their reputation the retail pharmacist leans with an assurance which is very praiseworthy. There is no necessity to say a word to shake so estimable a confidence in the wholesale dealers, especially as the temptation to adulterate powdered drugs is extremely small. But the retailer ought, in these days of contentious commerce, to be in a

position to demonstrate the grounds of his confidence to his customers if need be. In the matter of spices and condiments the druggist is on different ground, and must be content to see the greater part of his trade pass into the hands of the grocer, unless he can compete with him in price or sell a superior article. In order to be master of the situation the pharmacist must be certain of the quality of his goods, and he cannot do better than submit all his ground species to microscopical examinations. Cinnamon is sometimes mixed with starch, of which there should be normally present only a small quantity. Powdered walnut shells and the ground twigs of the cinnamon tree are also used for the same purpose. All these substances would be at once revealed by the microscope. Ground white pepper is not infrequently found mixed with other substances, such as foreign starches, ground olive kernels, walnut, almond and hazelnut shells. Exhausted coriander, fennel and anise fruits are also said to have been used for adulterating pepper. Ground mustard may contain an unusual amount of added starch, and it occasionally happens that such diluted mustard is fortified with cayenne pepper. Cheap arrowroot is not always what it pretends to be. Having a complaint as to the price of arrowroot, and hearing that a neighboring grocer was selling it at a low price, it was decided to investigate the matter by making a purchase from the said grocer. Accordingly, a small quantity of each of his two qualities was obtained. The difference between them was only the difference in the retail price ; the arrowroot was adulterated to the extent of between 30 and 40 per cent of sago meal. In justice to grocers, as a class, it should be said that the investigation was then extended, and samples obtained from ten other establishments ; these examples were all pure and of good quality. Linseed meal may sometimes be found to have an admixture of starch, and at other times, especially when old, it may contain large

numbers of a mite (*Tyroglyphus siro*). Powdered cantharides is also found sometimes to harbor mites, as is also saffron, especially when kept in a moist condition in tins. About ten years ago a friend sent a quantity of colorless powder from the bottom of a tin in which he had kept his saffron, of which he used considerable quantities. His suspicions were aroused as to the possibility of having been supplied with an adulterated article. The microscope at once revealed the nature of the powder; it consisted of innumerable mites, their eggs, and the debris of dead ones. Insects are much more common in the stock of the druggist than is generally supposed, and would be much more generally detected if the handy microscope were brought into use.

Another direction in which the microscope is rarely turned is towards the filtering papers. The nature of the liquids which a pharmacist has to filter is so various that it is of considerable importance to him that he should use filtering paper composed of suitable material. A microscopical examination will reveal such differences in the composition of the filtering papers in the market that he will be tempted to consider the whole question of filtration from another standpoint than that of price—namely, that of efficiency.

Besides the utility of the microscope in the immediate concerns of the shop, which have been merely indicated in the foregoing remarks, there is the wider application to the concerns of the community at large. This is a work the pharmacist is pre-eminently fitted to undertake. No other class of professional men has the same opportunities of acquiring so extensive and varied a knowledge of the minutiae of vegetable and animal substances. Medical men are generally very glad to avail themselves of the opportunity of sending urinary deposits to a skilled microscopist; and a pharmacist may, with a very small expenditure of time and money, soon making himself so pro-

ficient as to meet all the demands of his medical friends, and thus earn their gratitude and perhaps something more tangible. In many commercial centers where textile fabrics are handled there is a constant need for assistance in discovering the component parts of fabrics. Merchants are often dependent upon tricks, which have no scientific basis, to guide them in appraising the value of the textiles they handle. Whenever they can obtain demonstrative evidence of the presence or absence of certain fibres in their fabrics, they are quick to appreciate the help. This is a field of usefulness the pharmacist who lives in the proper districts should at once annex to his domain. The characters of cotton, silk, wool and linen, as seen under the microscope, are easily apprehended. Now that lustro-cellulose, mercerized cotton and weighted silk are so common, the aid a pharmacist can render by the use of his microscope should have a distinct commercial value.

The microscopical examination of articles of food, such as coffee, cocoa, flour and tea, can very well be undertaken along with the general work of the pharmacy. In the case of coffee, cocoa and flour, when the characteristics of the tissues of the genuine materials are mastered, the detection of adulteration is easy, and the substances used for falsification are so few in number that it soon becomes easy to name the adulterants. Where tea is concerned the microscopical examination may entail somewhat more trouble, as in some instances it may be necessary to make sections, and in all cases a careful investigation of the venation is required. There are, however, several works published which will help the microscopist over these difficulties very quickly.

The examination of water has been purposely avoided, because it demands expensive apparatus and a certain amount of technical training outside the ordinary curriculum of the pharmacist. There is no reason why the investigation of deposits in potable waters should not be

undertaken by the pharmacist; but unless the bacteriological character of the water is also ascertained, such an investigation is of little value. The phases of microscopy that have been exhibited here are just those which should commend themselves to the pharmacist who is willing, without any extra training or any increase in laboratory equipment, to turn to account the reserves of his scientific knowledge.—*Pharmaceutical Journal*.

Bacteriological Diagnosis in the City of Kalamazoo.

DR. A. W. CRANE.

In this city, we are agreed to recognize as diphtheria all inflammations of mucous membranes caused by the Klebs-Löffler bacillus whether or not there is a visible membrane and to recognize as diphtheroid (Osler) all inflammations and tonsillitis simulating diphtheria but not caused by the Klebs-Löffler bacillus. Not only cases of diphtheria but all cases which clinically would be diagnosed as diphtheria, especially laryngeal cases, whether or not diphtheria-bacilli are found, are placarded, until further bacteriological examinations can make clear the diagnosis.

No bacteriological examination is thoroughly reliable if made from a swab used within six hours of the application of antiseptics to the throat. The bacilli are present in the mouth and throat when the membrane is forming and when it is breaking down. But during the course of the disease while the mouth and throat are kept clean by washes, gargles and swabbing, the specific germs may be found only in the deeper portions of the membrane. The bacteriologic examination is not without certain qualifications. It must be done properly, and the conditions of the patient are almost as important as the conditions of the culture tube and incubator.

Any physician may obtain a sterile swab and culture tube free of charge at the Health Office laboratory, or a

drug store which is open nights and Sundays. The patient to be examined is given a drink of water to clear the throat of mucus. The tongue is depressed and the swab rubbed firmly over the affected surface. The swab is now rubbed gently over the surface of the solidified blood serum in the culture tube, so as to plant the germs from the throat upon the culture medium. The swab is returned to its own tube and both tubes sent at once to the laboratory where a second culture tube is inoculated by the bacteriologist from the same swab. These tubes are kept at 37° C. for about twelve hours (often less) after which a portion of the growth on the serum-surface is transferred to a cover-glass, stained with Loeffler's alkaline methylene-blue solution, and examined under the microscope. Diphtheria bacilli grow rapidly and luxuriantly on pure blood serum, while the other throat germs do not get much of a start until twenty-four or even forty-eight hours. If bacilli are present which have the morphological characteristics of the Klebs-Loeffler bacilli and show the end-staining reaction, the report is made that the Klebs-Loeffler bacilli have been found. If however (as is rare) bacilli are present which have the morphologic characteristics of the Klebs-Loeffler bacilli but do not show the end-staining reaction with Loeffler's solution, the report is made that bacilli are found which may be either diphtheria bacilli or pseudo-diphtheria bacilli. The patient is isolated and treated for diphtheria. In the meantime a tube of alkaline bouillon is inoculated with the suspected germs. If at the end of 48 hours the bouillon becomes acid in reaction the bacilli are called the Klebs-Loeffler; if the bouillon remains alkaline the bacilli are called the pseudo-diphtheria organisms. The hypodermatic injection into an animal of a quantity of this bouillon would constitute a test for virulence. In any case the quarantine is not maintained after the recovery of the patient when the true Klebs-Loeffler bacilli are not found. If requested by the

attending physician or the health officer, the bacteriologist inspects the case personally and applies the swab himself.

Thus by means of the bacteriological examination or examinations we know in what cases to give the diphtheria antitoxin, and when and how long to maintain the quarantine. Diphtheria-antitoxin has effect only in cases of true diphtheria caused by the Klebs-Loffler bacillus. The city of Kalamazoo provides free the administration of the antitoxin in cases of the city poor. It also provides free the bacteriological examination. The city is thus afforded the best obtainable protection by the early detection of true diphtheria and the prompt cure of cases. Of the humanitarian aspect I need not speak. The rapid cure by antitoxin saves expense to the city in cases among the dependent poor who must be furnished with provisions and attendance during quarantine. The bacteriological examinations also save expense to the city by maintaining quarantine only so long as the patient is a real source of danger. A further saving is effected by limiting the use of the expensive antitoxin to cases of genuine diphtheria, where only it can be good.

"The average practitioner is not in a position, and can not be considered competent, to make a bacteriological examination in a case of suspected diphtheria. The bacteriological method is most efficient in a city the size of Kalamazoo where all parts are accessible and where a report can reach the physician promptly in 10 or 12 hours. Usually the specimen is sent in at evening and the report given in the morning.—*Report State Board of Health.*"

Is it True?—"If you breathe on a piece of glass, and immediately apply a microscope thereon, you will discover tracings of beautiful foliage."—Albert Alberg, 439 31st street, Chicago, Ill. Will any of our readers who verify this please send descriptions of what they see?

BIOLOGICAL NOTES.

L. H. PAMMEL.

LICHENS OF MINNESOTA AND LAKE SUPERIOR REGION.—In the current number of Minnesota Botanical Studies (Part III) Professor Fink makes an interesting contribution to the knowledge of the lichens of Minnesota. The area included by Prof. Fink's paper comprises something like 5,000 square miles and the list furnishes many species that are new to the state and to the interior of North America. The author says in regard to the lichen distribution of the Lusten and Grand Portage region: "The great masses of ligneous and metamorphic rocks along the Superior and inland shore lines, the same rocks back from the shore lines and the coniferous and various other trees together with diversity as to temperature, moisture and elevation, all help to produce a flora richer in lichen species than I had expected to find. Though the annual precipitation of moisture for the area is not large, yet the comparatively impervious nature of the rocks causes the water to collect in depressions of surface, forming a multitude of lakes of various sizes whose moist borders are a veritable paradise for lichens and especially for lithophytic species. The dense forests also hold moisture and favor lichen growth. When one finds single branches of *Usnea longissima* Ach., five feet long, as we collected on Grand Portage island, he realizes the significance of the name. Here and in some other localities of the region studied the dying conifers especially are literally covered with this plant, other species of the genus and *Alectoria jubata* (L.) Nyl., all growing in a tangled profusion which obscures the host and when wet with rain or dew furnishes a view of surpassing beauty. Hardly less remarkable is the growth of *Cladonia rangiferina* (L.) Hoffm., in open woods near Mt. Josephine, single clusters measuring three or four feet across and reaching a foot in

height. This plant was also common on rocks and in crevices exposed to wind and sun, but was always much smaller in such locations. It is evidently not a natural pioneer among lichens, but grows after other plants have attacked the rocky substratum, or on a thin layer of soil in crevices, and best of all after trees or shrubs have grown sufficiently to protect it somewhat from wind and sun and have not yet become large enough or thick enough to kill it out. This same kind of ecological relation favors *Cladonia furcata* (Huds.) Fr., a variety of which was found fruiting only in such environment."

CROWN-GALL—Is the name of a disease occurring at the crown of many deciduous shrubs and trees particularly troublesome to fruit trees like the pear, apple, peach, prune, raspberry, cherry. Prof. J. W. Toumey who has investigated the subject concludes that it is due to a slime mould to which he gives the name of *Dendrophagus globosus*, which in its parasitic nature is closely allied to *Plasmodiophora*, the fungus causing club-root, but in other respects is allied to the *Myxogasteres*. It produces sessile sporangia which occur singly or in groups of two or three, one millimeter or less in diameter. The capillitium consists of a few, thick, blunt, sparingly branched, and irregularly nodular hollow threads; spores orange yellow, adhering in masses, smooth, galls 1½-2 millimeters in diameter are the most desirable for studying the organism. The stronger Flemming's fluid was found most desirable for fixing. The triple stain of safranin, gentian violet and orange were most satisfactory for staining. Multinuclear cells are frequently in the parenchyma cells of the diseased area, and a new center of growing tissue originates under the stimulus induced by the parasite. (Bull. Arizona Agri. Exp. Sta. 33.)

CHROMATOPHORES AND NUCLEI OF CYANOPHYCEÆ.—In a recent paper Zacharias discusses at some length the structure of Cyanophyceæ especially with reference to the

Chromatophores and "Central Korper" nuclei. In *Oscillaria* he was able to observe that the colorless central body is surrounded by a colored protoplasm, but it is by no means demonstrated that chromatophores such as occur in higher plants are found in *Cyanophyceæ*. In his recent studies he was able to make out fine granulations in cells of *Lyngbya*, *Oscillaria* and *Nostoc*. The substance of the central body is not homogeneous as a rule, in *Nostoc* however it is homogeneous. In *Gloiotrichia pisum* a homogeneous central body produces ridges which project into the colorless plasma. (Über die *Cyanophyceen* Abh. Gebiete. d. Naturw. 16: Separate.)

ANATOMICAL ATLAS.—The fifteenth Lieferung of the *Tschirch* and *Oesterle* **Anatomischer Atlas** is up to the usual standard in the excellent accounts and plates of the drugs considered. This part deals with the general as well as the minute structural details of *Flor. malvæ*, *Fol. malvæ*, *Fol. althææ*, *Rad. gentianæ*, *Anthodiæ cinaæ*, *Artemisia cina*, *Fol. digitalis*, *Sem. fænugræci*. This work is an invaluable guide in pharmaceutical laboratories where microscopical details of seeds or other parts of drugs are studied.

PLANT DISEASES.—Dr. M. Hollrung is the editor of the year book pertaining to plant diseases and their protection. The first year 1898 treats fully the fungus enemies of cultivated plants. The editor desires that authors send their papers on phytopathology to him at Halle, Germany so that they may be abstracted.

ropy MILK.—Archibald R. Ward gives an account of ropy milk (*Bacillus lactis viscosus*) which has a viscid capsule. The capsule does not stain when treated with common methods, but by extracting the fat with ether and staining with carbol fuchsine the capsule is shown especially well as an unstained area surrounding the individual. The capsule can be positively demonstrated by Welch's glacial acetic acid method and by the Gram method. The

organism does not produce gas in any of the sugars, an exposure of ten minutes to 50°C. destroys the organism. There is reason to suspect that this organism comes from water. (Bull. Cornell Univ. Agrl. Exp. Sta. 165.)

ANÆROBIC DEVELOPMENT OF BACILLUS PRODIGIOSUS.—George Ritter states as a result of his investigations that peptone is not sufficient to cause the anærobic development of *Bacillus prodigiosus* but that it requires either grape sugar, cane sugar or maltose. It never produces gas. (Centralbl. Bakt. in Parasitenk. Abt. II 6 : 206.)

RANCID BUTTER.—Reinmann who has investigated the cause of rancidity of butter states that the amount of free acids in butter has nothing to do with rancidity, but a high percentage of casein and milk sugar is favorable for rancidity. Of seventeen species tested not one produced rancidity, such as *Bacillus acidi lactici*, *B. coli-communis*, *B. mesentericus vulgatus*, *B. butyricus Hueppe*, *B. fluorescens liquefaciens* were tested. It is undetermined whether rancidity is due to micro-organisms or ferments. (Centralbl. Bakt. in Parasitenk. Abt. II 6 : 131, 209.)

LACTIC ACID FERMENTS AND CHEESE RIPENING.—Freudenreich and Jensen who have investigated the ripening of Emmenthaler cheese state that the so-called *Tyrothrix* bacteria takes no part in the ripening of Emmenthaler cheese, but on the contrary act injuriously. The lactic acid ferments are important since they dissolve the casein and produce the characteristic products. The lactic enzymes of Russell and Babcock are important in the ripening since they render soluble the casein and allow the lactic acid bacteria to develop. (Centralbl. Bakt. u. Parasitenk. Abt. II 6 : 140).—L. H. PAMMEL.

Wanted.—Microscopic preparations illustrating the histology of petals and sepals. Would like to get a full set for John H. Lowell, Waldoboro, Maine.

Miscellaneous Notes on Microscopy.

JOHN. H. COOKE, F. L. S., F. G. S.

PREPARATION OF MARINE WORMS.—With a view to preserving the minute blood vessels of *Nereis* from decomposition, Dr. H. C. Sorby experimented with many reagents, but rejected all of them in favor of glycerine. His method is, briefly, as follows:—Specimens measuring from two to three inches in length were killed by placing them in strong glycerine diluted with an equal volume of water, and were afterwards immersed in fresh water for ten minutes to eliminate the glycerine. They were then arranged on a microscope slide, and dried very quickly in the open air at the ordinary temperature. A cell built of glass slips was attached to a slide, and the specimens were mounted in balsam and protected by a thin cover-glass in the usual way. Dr. Sorby has specimens that were treated thus two years ago, and they not only show no signs of change, but the structure of the animal is more clearly defined in the preserved state than it is when the animal is alive or recently dead.

MICRO-PHOTOGRAPHY.—At a demonstration recently given before the Royal Microscopical Society of London, Dr. Spitta exhibited some very fine micro-photographic work which he had done with lenses by Zeiss, Powell, Beck, and Wray. He spoke very highly of the one-eighth apochromatic N.A. 1·40 by Zeiss, which he considers to be “the finest lens in the world” for micro-photography.

STAINING BONES.—Mr. W. Colquhon has been experimenting with staining processes for the purpose of differentiating the canaliculi in bone. None of the usual methods gave satisfactory results, for though the nuclei of the bone corpuscles were stained, the outlines of the canaliculi were only faintly shown. Glass tubing was, therefore, arranged in lengths of twelve feet on a wall, and a bone with the head sawn off, the medullary cavity clean-

ed out and one end corked, was connected with the glass tube by means of a wide rubber tube. The periosteum was removed, and any holes visible on the outside were plugged with wooden pegs. The tubing was then filled the whole length with stain, to which a little antiseptic had been added. The bone being in a dry room, dried, and as this occurred the stain was drawn in to take the place of the evaporated moisture. After about a month all of the nuclei of the bone cells were found stained, and also the lining membranes of the canals. The bone matrix remained unstained, but the canaliculi were faintly outlined.

NEW LAMP.—An electric microscope lamp has recently been placed on the market by Messrs. J. Swift & Son. It was designed by Mr. J. E. Barnard to give an evenly illuminated field in the microscope, without the image of the filament of the incandescent lamp being thrown up from the mirror in the field of view. This is effected by a light from the incandescent filament falling upon a flat plane placed at an angle of 45° to the axis of the lamp, and the surface of which is covered with a preparation which throws off an intensely white light in such volume that the largest mirror of any microscope can be fully illuminated. The lamp is mounted on a swivel, enabling it to be placed at any angle, and can also be lowered or raised at will.

SCREEN.—The focussing of a microscopic object on a ground glass screen requires much skill and care. The screen which is supplied with the ordinary camera is generally too coarse, and in high power photo-micrography even the finest ground glass obtainable does not always give satisfactory results. For critical and medium work it is essential that the focussing screen should be, as far as possible, without grain. A simple way of preparing such a screen is as follows:—Take an unexposed photographic dry plate and immerse it in a solution of chloride

of barium for ten minutes. Transfer it to a bath of dilute sulphuric acid and gently rock the solution to and fro until a fine, even precipitate of barium sulphate has been deposited. Wash and dry the plate, and it will be ready for use.

FOCUSING.—Find the centre of the ground glass screen and then place a large circular or square cover-glass on it with Canada balsam. To do this, warm the ground glass carefully, add a drop of rather thick balsam to the centre on the ground side, and then apply the cover and press it down firmly. Put it away on a warm shelf for a few days to harden, after which the excess of balsam may be removed from the edges with the aid of a penknife and xylene or alcohol. The balsam will fill up the inequalities in the glass, and being of about the same refractive power will make this part of the glass clear as if it were unground. The focusing screen as thus prepared with a clear centre, serves both for the general focusing and the finest focusing, and avoids the danger of using the double screen.

OPAQUE OBJECTS.—For the photography of opaque substances, such as metals, &c., a metal microscope, such as that which is made by Reichert, of Vienna, is necessary. The microscope must be fixed in an upright position, and reflected light used. The source of light should be at a distance of one to one and a half metres from the apparatus, and must be on the same level as the reflecting lens at the side of the vertical illuminator on the tube of the microscope. The specimen should be everywhere equally illuminated and then focussed. Eosin plates and the use of a yellow screen are to be recommended for this work.

PLATES.—The selection of plates and screens for photomicrography is of practical importance, and should receive careful attention:—For stained preparation orthochromatic plates give the best results, but it is of advantage to place a screen, complementary in color to the stain

used, between the source of light and the microscope. Generally speaking, a light filter of picric acid should be used for specimens stained dark red, or violet; for light red stains, a greenish-yellow one; and for preparation stained with methylene blue, a dark orange-yellow filter is recommended.—*Knowledge.*

Notes on Microscopy.

F. SHILLINGTON SCALES, F.R.M.S.

OPAQUE objects are illuminated by several methods. The most frequent way is to focus the light directly upon the object by means of a bull's-eye stand condenser, remembering that the flat of the condenser must be nearest to the object and quite close to it, the focus being short. If a lamp be used, it will be necessary to raise it well above the stage. A better way is by the use of a "side silver reflector," which is a small, silver, parabolic mirror, placed close to the object and reflecting the rays of light thereon from a lamp placed quite near and about level with the stage. Its management is soon learned. Perhaps the most perfect means of illuminating opaque objects is by the now but little used "Lieberkuhn." This is really a speculum fitted above and around the objective, the light being thrown from beneath the object and reflected down again upon it. Its disadvantages, and those which have caused it to be largely disused, are that each objective must be fitted with its own Lieberkuhn, and that the object must be mounted not upon a black background, but in such a way as to give an annular ring of illumination round it. When we deal with mounting, we will point out that the generally recommended method of mounting opaque objects upon a black background is not only unnecessary, but inconvenient. The writer invariably mounts such objects in an ordinary cell, and puts under them a plain slide upon which a disc of black paper has been fastened. What more is needed?

Before leaving the subject of illumination we will deal with the bull's-eye condenser. In one of our earlier papers (*Science-Gossip*, Vol. VI., N.S., page 215) we have alluded to the enormous spherical and chromatic aberrations of this lens, and these render it unsuitable for really critical work on account of its bad definition. For this reason we do not advocate its general use, save for opaque illumination. Should it be necessary, however, to fill the field with light by its means (see page 215) we would ask our readers to bear its optical properties in mind and to remember that to obtain parallel light the condenser must be placed close to the flame of the lamp, and with its flat side against the flame. The bull's-eye must, of course, also be placed both centrally and at right-angles with the direction of the light. It is an assistance to beginners if they do their focussing, both with bull's-eye, and even with condenser, upon a sheet of note-paper placed in the requisite position. If the bull's eye be used, it must be properly and carefully adjusted, or it will only interfere with the proper focussing of the condenser.

To pass now to the focussing of the object itself. This needs but little explanation, but it may again be advisable to point out (see page 157) that the so-called focal length of the objective does not in any way represent its distance from the cover glass of the object. In fact, with increase of aperture, the objectives have got closer and closer to the object. When using high powers it is a help and sometimes a preventive of damage, if the aperture of the stage, as is customary in English stands, is made sufficiently large to admit of the insertion of the finger underneath the slide so as to slightly lift or tilt its fore-edge. A high power can then be safely brought down upon the object, and the approximate distance being found, the finger can be removed, and the objective then brought gently to its ultimate focus.

We do not think it advisable here to explain the use of

the correction-collar or adjustment of tube-length for differences in the thickness of cover-glass. This has been fully dealt with in an earlier paper (*Science-Gossip*, Vol. VI., N.S., p. 184); but it really requires a trained and critical eye, as well as a critical object, to enable these adjustments to be satisfactorily made. We may, however, remind our readers that the oft-met-with instructions as to varying the magnification by the simple device of altering the tube-length are not really practicable save for very rough-and-ready work, and we recommend our readers to find out at the time of purchasing whether their objectives are corrected for the 6½-inch or 10-inch tube, and to remember that they perform properly only on the tube for which they are designed. Most students' objectives (for an unsatisfactory reason connected, we believe, with foreign competition) are corrected for the short tube; but makers have a misleading habit of giving in their catalogues complete lists of magnifications calculated as if they were corrected for the English 10-inch tube-length and vouchsafing no hint as to the real facts.

There are a few more suggestions that may be useful to the beginner. The first is to remember never to use a stronger light than is necessary. Nothing is more fatiguing to the eyes, or more likely to work mischief, than excessive glare; but if reasonable precautions be taken, we do not believe the use of the microscope is injurious to the eyesight. Some people are much troubled with what are called "floating flies" in the eye, but this is to a certain extent a question of ease of position. The second rule is to accustom oneself to keep both eyes open. The screwing-up of the eye not in use is a most injurious and unnecessary habit. At first, doubtless, some difficulty will be found, and the eye that is not looking down the tube will be distracted by external influences; but this difficulty is only temporary, and a little perseverance will overcome it. Some writers recommend a shade, but we

have advised many beginners to commence simply by holding the hand a short distance from the eye, and to gradually move it further away as they gained experience, until finally it was no longer necessary at all. All workers have a tendency to use one eye more than another; and in this case the eye most used becomes generally rather less sensitive to brightness of image, but more capable of perceiving critical points. But every worker should learn to use either eye with equal facility.

Various tints of blue or yellow glasses, or a disc of ground glass, are useful for moderating the light, and in some cases for accentuating the image.

Remember to use no higher magnification than is absolutely necessary. The real microscopist uses the lowest power that will serve his purpose, for reasons that a very slight acquaintance with the microscope makes abundantly evident, and in all probability the most generally used lens is that of the modest inch.

Remember also that the fine adjustment is a delicate piece of mechanism, and then endeavor to save it (and the mechanical stage, if there be one) from the very first. Any one of the microscopes we have described will satisfactorily and easily focus $\frac{1}{2}$ inch by means of the coarse adjustment alone. Do not bear heavily upon any of the adjustments; endeavour to balance them gently between the finger and thumb, that the motion may be uniform; and do not on any account roll the fine adjustment by pressing one finger to one side only of the milled head, or else trouble may follow.—*Science Gossip.*

MICROSCOPICAL NOTES.

Society Screw.—The details of screws for objectives prescribed by the Royal Microscopical Society in 1857 are: Whitworth thread, i. e., a V-shaped thread, sides of thread inclined to an angle of 55 deg. to each other, one-sixth of the

V depth of the thread being rounded off at the top of the thread and one sixth of the thread being rounded off at the bottom of the thread. The pitch of the screw is, 36 to the inch; length of thread on object-glass, 0.125 inch; plain fitting above thread of object-glass, 0.15 inch long, to be about the size of the bottom of male thread; length of thread of nose-piece on the lower end of the microscope tube not less than 0.125 inch; diameter the object-glass screw at the bottom of the screw, 0.7626 inch; diameter of the nose-piece screw at the bottom of the thread, 0.8 inch. See Jour. Roy. Mic. Soc., Aug., 1896; Proc. Amer. Mic. Soc; 1884, 1886, 1893. It is remarkable that no description of the Society Screw is to be found in "Carpenter on the Microscope."

Wanted.—Earth containing diatoms from Redondo Beach for a European subscriber who offers cash, or, in exchange, Hungarian diatomaceous material from St. Peter. C. W. — S.

New Publications.

ACETYLENE is the title and subject of a profusely illustrated work of some five hundred pages which the Macmillan Company will publish at an early date. The history of the origin, properties, and application of this gas is very fully treated, and the cuts, of which there are upward of one hundred and fifty, add greatly to the descriptive value of the text.

PLANTS, A TEXT BOOK OF BOTANY, in two parts. Part I, Plant Relations. Figures 206, pp. 264. Part II, Plant Structures, Second Book of Botany, Figures 289, pp. 384. D. Appleton & Co., 1900.

Prof. J. M. Coulter, Head Professor of Botany, University of Chicago, Ill. is the author of an admirable text-book of botany which is intended as an introduction to the science. The two parts have been prepared as independent volumes for the reason that some schools cannot give but a half-year to botany. The subject of each part covers one-half year. The volume is intended as introduction to the study of botany. The author has certainly succeeded.

ed admirably in presenting the subject of plant life either from the standpoint of structure or their ecological relations. The work is handsomely illustrated and the text throughout is lucid and clear. Prof. Coulter has the faculty of being able to make his meaning clear and the English throughout is excellent. In the prefatory note he states that either volume may be used separately and one may precede the other but he has very properly allowed the subject of plant relations to precede that of structure. Ecology if properly presented will give a proper conception of the place of plants in nature. It ought to broaden the students conception of living plants. Throughout the volume this point has been kept uppermost, and many suggestive facts are brought into prominence. The variability of plants with reference to their surroundings and their relation to their environments is a subject which should be kept uppermost in the studying of plants at least for the beginner. It is far better to bring the student in direct contact with nature than to try to start with technical terms. The book throws out suggestions rather than giving all the facts with reference to each topic. The work cannot be reviewed in detail but altogether the first part is the best American text on this subject recently published, both in the subject matter and typographically. The chapter on flowers and insect relations as well as the one on the dissemination of seeds are refreshing and the facts are marshalled in a very systematic and orderly way. The chapter dealing with hydrophyte, xerophyte, mesophyte, and halophyte societies is certainly admirably presented; moreover, the illustrations are superb. Such problems as reproduction, the plant body, isogamy, heterogamy, algæ, fungi, mosses, ferns, gymnosperms and angiosperms are discussed in detail. While the work presents many technical details the facts are well ordered and lucidly presented. The work is surely well adapted for secondary schools and can be most heartily recommended. A valuable part of the work is the suggestions to teachers by Dr. Caldwell and Prof. Coulter, each of the parts having one of these suggestive outlines.—L. H. PAMMEL.

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CONTENTS.

The Evolution of a New Diatom Find.—Cunningham	181-188
Experiments to Determine the Cause and Dissemination of Texas Fever.—Salmon	199-203
BIOLOGICAL NOTES.—PAMMEL.—Centrosomes in Plants; Fungi; and Humus; Leaf Scorch; Red Color in Plants; Fertilization; Incandescent Light on Plants; Antipodal Cells; Diatoms; Oxygen; Fungus; Yeast; Cell-Membrane	188-192
NOTES BY J. H. COOKE.—Water Bugs; Illumination; Media; Blood Crystals; Haemoglobin; Magnesium; Diatoms; Fish- Teeth; Fungi; Dead Black; Radiolaria; Rotifers; Moulds; Realgar; Diamonds; Microtome; Epidermis; Metals	192-199
NOTES BY SCALES.—Botanical Slides; Malaria; Nails; Num- mulites; Wood Sections; Locust Disease; Liverpool Society; Condenser; Embedding	204-209

The Evolution of a New Diatom Find.

K. M. CUNNINGHAM.

In the career of all who become at some period of their activity infatuated with the study of the diatoms there occur epochs in which some particular find may prove of a more romantic character, than all preceding researches. It is an epoch of this character that I desire to place on record before it loses its present interest.

In the spring of the year 1896, I had occasion to observe the novelty of dredging the Mobile River in front of the city wharves at Mobile, and on one of these occasions, merely desiring to secure a souvenir of the ancient debris that was being exhumed, (not having the diatoms

in view as I believed the depth of the river to be barren of such material), I chanced to observe what at the distance seemed to be an iron cannon ball. Forthwith, I decided to go aboard of the dredge scow, and secure the trophy. It proved to be merely a very old and small black cocoanut. Thinking that an ebony-black cocoanut was about as good as an iron ball for a souvenir, I conveyed it to my residence with a view to polishing it up as an ornament. In the attempt to clean out the internal parts of the cocoanut, I found a small quantity of black oozy mud, and a pasty substance, which thrown into the coal grate fire began fizzing and flaming, thus recognizing some fatty substance therein.

I carefully saved the contents and melted it down in boiling water, and then shaped it into a ball of cocoa wax. Under the microscope, small streaks of this, when heated gave the characteristic crystals of Cocoa butter under polariscope, thus calling attention to the chemical alteration known as adipoceration, when referred to the action of animal substances submerged under water for lengthy periods. Next having turned my attention to the contents of the small quantity of black mud derived from the cocoanut, a trial or two under the lens showed me that I had struck a diatom-bearing material of a novel character, and a combination of species hitherto not readily found in this locality.

According to my custom, I promptly advised the well-known connoisseur and expert preparer of diatoms, Mr. C. L. Petricolas, of the character of my new find, and I forwarded a small portion of the new material to him for his own study. In my communication, I told him that I had found species of *P. formosum*, *Chætoceros boreale* of 12 or more frustules united, *Hemiaulus*, *Bacteriastrum*, *Rhizosolenia*, *Melosira* in long filaments, and a form that proved to be *Skeletonema costatum*. In a short time Mr. Petricolas advised that he found nothing whatever in the sample

that I had sent him, that he had taken great pains in its cleaning, and therefore his labor was futile. In order to show the rigorousness of his search he averred that he had used a lens in the search that would resolve *A. pellucida*.

His adverse report did not shake my faith in what I knew I was absolutely certain of. So to convince him that the material was all right, I prepared three simple "proof slides," in this manner; the dry material was softened to a liquid mud, and spread for a space equal to one-half the length of the slide, then dried over a flame. This method did not require a cover-glass, merely a plain slip. The three slides of this character, examined by condensed light and a half-inch objective, would have shown anybody all that I claimed from my preliminary study in the rough. This proof-set of slides had reached his hands, but were sureptitiously removed from his residence before he could examine them. He advised me of this, and I prepared three more "proof slides" of the same character. At the same time I made a suggestion so that he could follow my method of manipulation. Mr. Petricolas received the last batch of "proof slides" and then became convinced that there was no possible error discoverable in my new find.

With the remnant of the initial specimen that I sent him he determined the novelty and beauty of the new find, charmed with his own results in its preparation. He sent me a letter acknowledging the benefit of my tutelage, to an expert of many years standing. The interesting character of the new find as elaborated by himself, led him to say that if possible, he would like a larger quantity of material to study out its possibilities. So I forwarded to him every remaining particle of the cocoanut material. Shortly after its receipt, he returned, prepared out of the material, five slides marked Nos. 1 to 5, of what he designated as the "Cocoanut series, Mobile Bay," and sug-

gested, for reasons satisfactory to himself that the cocoanut was a waif stranded from tropical regions, as it contained *Skeletonema costatum*, a species hitherto not recorded for American waters, but for Europe and Asia. At the same time, in appreciation of the same, he said that the "cocoanut series" could not be duplicated in the U. S., thus constituting a feature of special interest to those studying the diatom. In the interim, I found that there was little hope of securing a sufficient quantity to distribute at large. The dredging had stopped immediately after the character of the material was known, and there was no further prospect of securing additional specimens.

From the time in 1896 when I suspended correspondence with Mr. Peticolas, the ensuing years ran by without anything of interest occurring until one day in 1899. Dr. Vida A. Morse of Chicago, opened a correspondence, and incidentally called my attention to the fame of the material from "Cocoanut Bay, Mobile." This was not the original title given by Mr. Peticolas to his series, but it was near enough to identify its origin. Dr. Morse had but recently become interested in diatoms, but had already gathered slides from many eminent preparers, desired assistance in increasing his collection and a larger acquaintance with the subject, as pathology had been his chief specialty in a professional way. I had always been happy to respond to any correspondent interested in my field of study, and the complimentary nature of his initial letter induced me to revert again to the search of the hidden field. It was explained by Dr. Morse, that while in Cincinnati, in company with a group of Diatomists, the character, novelty and richness in species of the find referred to as the "cocoanut find" seemed to possess the highest interest to those discussing it, and this incidentally fixed the subject on his mind.

While the correspondence was running, Mr. Fr. Die-

nelt of Leda, Illinois, also for the first time, communicated with me in complimentary terms, stating that while he did not prepare the diatoms, he still had an admiration for them, and had many fine slides of various preparers his specialty having been chiefly insect preparations.

In the desire to be agreeable, as well as accommodating to those who honored me with their correspondence, my attention was again turned to the Mobile River deposit. I did not know how to master the problem, but I took it up, out of regard to my new correspondents, and made the attempt as follows: I knew before hand, that the space before the wharf had been dredged to a depth of 20 feet, and that the diatom-bearing stratum must be below that depth if not covered with coarse sandy silt. So I provided myself with a lead sinker, surrounded with a stiff paper bag. This was let down from a tug lying out in the river, and when bottom was reached the bottom surface was dragged, and plummet drawn up. The result was uncertain, as the plummet and paper gave no mud reaction, but established a depth of 20 feet of water, and a strong dragging current. So, to get a sample of the bottom would require a pole 25 feet long with an augur, or hollow iron pipe attached to it. I then deemed this too difficult to handle and abandoned the project for that point; but later on revolving the subject in my mind, and still devising a method to accomplish my results.

I went to the Mobile Dry Dock, a point on the river front, but quite in reach of the central part of the city, that is, a few minutes walk, whereas the other two already recorded diatom deposits are respectively a mile to the north, and two miles to the south on the water front, and are entirely dissimilar from the deposit referred to herein. It was while gazing at the dry dock, that I casually noticed a 30-foot measuring strip lying near by and I immediately decided to utilize it then and there.

I immersed the pole at a few points and found obstructions, a moment later it struck a soft place and I forced it down as far as I could, and then withdrew it. On getting it out of the water, I found that it had penetrated 18 feet of water, and five feet of black oozy mud. This seemed to augur for good. I gathered together the single sample thus secured. On taking it home, and by trial under the microscope, I found that I had secured a deposit that had escaped my scrutiny for the total period that I had been in pursuit of all kinds of diatoms, more than 22 years. This spot had been visited innumerable times in that interval. After I had established the permanency and extent of the deposit, I knew that in the future, a supply would be conveniently accessible to anyone who might desire any quantity, great or small.

The next stage of work after establishing the deposit, was to secure several pounds of the material. I carried on a rather extensive study of the contents until I became fairly well acquainted with it. In succession I forwarded three study preparations of the new find to Wm. A. Terry of Bristol, Conn., who kindly sent me a list of the principal species noted by him in the slides, and also a few slides prepared by himself from some of the crude deposit sent to him. He suggested, however, that he had not observed any species therein that he had not already found in his researches along the Connecticut Shore.

To Mr. C. L. Peticolas, I forwarded a quantity of the crude "new find" and, in a short while, I had the pleasure of inspecting three of his beautiful preparations. His final conclusion was, that in all of his diatom experiences he had not met with an identical deposit, combining marine and fresh-water forms and covering a so extraordinary number of species. He desired a larger quantity of the material so that he might make an exhaustive study of the curious deposit and in the labels attached to his slides of this series, he adopted the title: "Marine and fresh-

water diatoms, Valleys of Tombigby and Alabama rivers and Mobile Bay," thus making a broad inference to cover the probable source or origin of the newly found deposit.

Before this suggestion had reached me, I had settled on the theory that the deposit was the result of submergence of a marine salt-water marsh, as there are in it myriads of Foraminifera, Rhizopods, Sponge spicules, lignitized-wood fragments, pine pollen, fern spores, and many kinds of vegetal tissues. The remarkable occurrence of some eight species of *Pleurosigma*, therein indicated the analogue of the recent salt water marshes of the Connecticut shore, so fully reported on by Mr. Wm. A. Terry in former numbers of this Journal.

For years past I have sought in vain for superficial water bodies near salt water, along the Gulf coast, giving indications of *Pleurosigma*, and it is only in the deposit now on record, that they were found in characteristic numbers and quantity for the first time. Thus, at the close of twenty-two years I have practically studied, and distributed at large, all that is of interest to the pursuit and study of the diatoms for this region.

This particular deposit fills the missing link that I had hoped for in the fall of 1888, at which time I prepared a type-slide of all species then available in the territory contiguous to Mobile. That slide was referred to in an article contributed by myself and printed in "The Microscope," April, 1889, and now we are offered a chance to contrast the newly found deposit, with an old slide containing an aggregation of more than 1,500 separate diatoms.

The type slide as studied by J. D. Cox, showed some 90 species and varieties; as a result of working on fresh-water, and salt-water diatom sources, such as bay, river, pond, creek, lake, bayou, marsh, and swamp; all of the above sources merely providing recent species. In three crude study-slides submitted to Wm. A. Terry, he casu-

ally listed 58 species while I have noted species under twelve genera, not in his list, and a number of species not listed, under the genera comprising his list. Mr. Peticolas gives the *coup de grace* to the deposit by stating that he was somewhat astonished by the "extraordinary number of species" that he had found in the puzzling deposit.

Taking a retrospective glance, I might note, that it was in the year 1878, that by casually finding a copy of "Bailley's Microscopical Observations, made while on a Trip to the South," that the writer became inoculated with the diatom infatuation if it be such, and through a double decade has followed the study faithfully under the guise of Micro-geology. I now have the impulse to inscribe herein *coronat opus est*; leaving as a hint to those who may desire to tread a like path: Secure a type plate preparation of this new deposit from whatever source it may be secured, and with the aid of the modern, perfected, oil homogeneous, and apochromatics, endeavor to work out from the same, following in the footsteps of Nelson, Smith, Cox and others the secondary and tertiary details of such a slide. Life would then be filled with pleasures of the sight and mind, unknown to the founders of the diatom culture through the first three-quarters of the Nineteenth Century.

MOBILE, ALABAMA, July 5, 1900.

BIOLOGICAL NOTES.

L. H. PAMMEL.

CENTROSOMES IN PLANTS.—According to Strasburger in his recent work, *Histologische Beitrage*, the subject of centrosomes is fully discussed. He admits the connection of the spindle fibers with extranucleoli. These stand in close relation to the kinoplasm which they are regarded as activating. The bodies which different writers have regarded as centrosomes are nothing more than these escaped nucleoli. In *Nymphaea* which is said according to

some writers to have centrosomes, Strasburger states that these granules are not centrosomes, but that the spindle often reaches to and ends on the peripheral layer of the cytoplasm in multipolar way. The blepharoplasts are but remotely related to them.

FUNGI AND HUMUS.—According to F. Reinitzer (Bot. Zeit. 58: Abt. 1.59) humus is not a favorable medium for the growth of saprophytic fungi. In the experiments made by Reinitzer the soluble matter was removed. It was found that such fungi as *Penicillium glaucum*, *Botrytis cinerea* did not grow or only with difficulty. The humus consists of waxy aldehydes. These experiments confirm those of other investigations that humus is not food for plants.

LEAF SCORCH.—According to F. C. Stewart, Leaf Scorch is a physiological disease. Whenever the quantity of water transpired by the disease is greater than the roots are able to supply, leaf scorch occurs. The factors entering into this problem are the area of leaf surface, exposure, quantity of water in the soil, activity of the roots, the location of the trees as exposure to wind. M. Stewart records that *Gleditschia triacanthos*, hickory, sugar beets, cherries, and maples were affected by this disease.

RED COLOR IN PLANTS.—The recent researches of Overton on the red cell-sap of plants shows that its occurrence is conditioned upon the presence of sugar, and that the depth of the tints depends upon the concentration of sugar. Low night temperatures induce the development of such colors, which the author believes accounts for the reddish coloration of alpine species and to the same cause are due the yellowish-red tints of evergreen leaves during the winter. If two plants of the ordinary bladderwort (*Utricularia*) are grown in separate dishes of water containing different proportions of sugar, the relation of this substance to color production can be verified.—(Journal N. Y., Botanical Garden).

FERTILIZATION OF CYSTOPUS CANDIDUS.—In a previous number of this Journal attention was called to a paper by Mr. Stevens on the fertilization of *Cystopus bliti* in which a large number of nuclei pass into the ooplasm when the oosphere is differentiated and that they are doubled in number by mitosis so that when ready for fertilization the oosphere contains about one hundred nuclei. About an equal number of sperm nuclei enter the oosphere from the antheridial tube, these fusing with the female nuclei. Dr. Davis who has studied the allied *C. candidus* finds that this species is uninucleate. One of the nuclei from a point near the periphery of the ooplasm slips back from the center and takes a position near the *cœnocentrum*. The *cœnocentrum* is not a permanent structure. The nuclei of *C. candida* are very small and the mitotic figure is difficult to make out. The *cœnocentrum* disorganizes at about the time of the fusion of the sexual nuclei. (Bot. Gazette 29 ; 297).

INCANDESCENT GAS-LIGHT ON PLANT GROWTH.—L. C. Corbett concludes from the study of the effect of incandescent gas-light on plant growth that the gas-light from a Welshbach burner is an active stimulus to plant growth when used at night to supplement daylight. Lettuce plants were taller and heavier than plants of the same variety and seed sowing grown under normal conditions. Lettuce as well as spinach grew faster and completed their growth in less time than plants of the same sort from the same seed sowing grown in normal conditions. The most susceptible plants were in the following order : spinach cabbage, radish, lettuce, tomato. The maximum growth was attained at 12-16 feet while a small increase was noticed at 24 feet. In case of tomatoes the flowers appeared earlier, eight days being the least and eighteen days the greatest difference. (Bull. West. Va. Agri. Exp. Sta., 62).

ANTIPODAL CELLS IN GRASSES.—Canon states that the

antipodal cells in the embryo sac of grasses may best be studied in grasses with large ovaries. They form either before the fertilization of the egg or subsequent to its large cell complexes. For fixing, hot solutions of corrosive sublimate in alcohol and chromic acid were used working up through the alcohol and into paraffine. He uses paraffine of two melting points 43° C. and a mixture of 72° C. and 54° C. The specimens are placed in the 43° C. paraffine first and allowed to remain in it two days, then transferred to the mixture of harder paraffine, and left in this bath two days longer. The specimen should be kept in paraffine at its melting point as near as possible. (Jour. Appl. Mic. 3 : 718).

PORES OF DIATOMS.—O. Muller who has investigated the pores of Diatoms has made some rather interesting observations on some of the species with gelatinous pores: in the genera *Diatoma*, *Tabellaria*, *Grammatophora*, *Syndra*, *Licmophora* and *Fragilaria*. In nearly all these genera the author was able to demonstrate the presence of pores through which the mucilaginous plasms was issued.

ONYGENA EQUINA.—H. M. Ward has discussed a fungus which occurs on organic substances like hairs and hoofs. The ascospores when heated at 35° C. and over, with digestive juices or when digestive juices are added to the fluid, germinate. The optimum for germinations is 22° C. The chlamydospores also germinate in the presence of digestive juices as well as without. (Philosophical Trans. Roy. Soc. of London. Ser. B. 191: 269-291. Pl. 21-24).

INHERITANCE OF AN ACQUIRED CHARACTER IN A FUNGUS. Errera has found that in cultures of *Aspergillus niger*, the conidia adapted themselves to concentration of a medium and that this is transmitted to a second generation, that is that the organisms were capable of growing more readily in the second generation than the first and these or-

ganisms were less able afterwards to adapt themselves to a less concentrated medium. (Bull. Acad. Roy. Belgique, 1899, p. 81).

YEAST.—According to C. C. Lintner yeast has the power of forming alcohol and carbonic acid at the expense of its own body, without the addition of sugar. The material for this self fermentation is glycogen which is first converted into grape sugar and then into alcohol and carboxylic acid. (Centralb. Bakt. u. par. abt. 5: 793.)

CELL-MEMBRANE OF THE MUCORINEÆ.—According to M. L. Mangin the cell-wall in the Mucorineæ presents characters that are different from other Oomycetes. In *Peronosporæ* and *Saprolegnia* the cell-wall is partly formed of callose but it is usually wanting in Mucorineæ. It consists of cellulose associated with pectic compounds. The cellulose is more resistant to chemical agents. (Jour. de Bot. 13: pp. 209, 276, 307, 339, 471, pl. 2, 7 figs).

Miscellaneous Notes on Microscopy.

JOHN H. COOKE, F. L. S.

WATER BUGS.—The residua and strainings obtained from ordinary tap water will provide the microscopist with an abundance of material for examination. Among the organisms that he will probably meet with are the fat little rotifer, *Triarthra longiseta*, hobbling along on his long delicate stilts in company with the pretty, little, long spined *Anurea longispina*. The *Vorticellidæ* and *Entomostraca* are often in great force, with diatoms and desmids innumerable. *Dinobryon sertularia*, a curious compound flagellate organism, like animated ears of barley, though not so numerous, are invariably present in greater or lesser numbers. A bag made of several thicknesses of very fine muslin and tied on the water tap, so that the water strains gently through it, is a rough and ready, but, on the whole, a satisfactory way of capturing them.

ILLUMINATION.—Sunlight is par excellence the best source of illumination for phoomicrography. A good substitute for a heliostadt is a fair-sized mirror swinging on a double axis, and capable of being regulated by hand. No difficulty is experienced in keeping the light centred, as exposures by sunlight, are of such short duration. When using sunlight, care should be taken to pass the rays through a cell of saturated solution of alum, in order to absorb the heat rays, otherwise serious damage may be done to the objective and the sub-stage condenser. After sun-light, diffused daylight from a window with a northern exposure is the next best light at the disposal of the photo-microscopist, but when it is necessary to use artificial illumination, acetylene gas or magnesium wire will be found to give satisfactory results. Some objects are better shown under a diffused light, such as may be obtained by the interposition of a ground-glass screen, or near a window without the aid of a condenser. If the color of the object be dark, or reflects but little light, the bull's-eye should be focussed on the specimen, care being taken to avoid glare or excess of illumination, which will result in a confused image in the negative. With some objects, Lieberkuhn may be used advantageously, with others the parabolic reflector, but the majority yield better results under the most simple forms of illumination.

MEDIA.—Potato-agar is suggested as a good cultivating medium for thermophilous bacteria. It is prepared as follows:—Potatoes are steamed, peeled, and pounded. To 100 grammes of potato add one litre of water, steam the mass for half an hour and then filter. To the filtrate add two per cent of agar and autoclave the whole for fifteen minutes. It has been found advantageous to add one per cent of salt. After neutralization with soda, and further steaming, filter the potato-agar into test tubes and sterilize once more.

BLOOD CRYSTALS.—A practical way for obtaining crys-

tals from dog's blood is suggested by Dr. S. Waterman. Defibrinate and mix water in equal parts to each volume of blood. Add to four volumes of the blood solution one volume of alcohol. Set the mixture to rest for twenty-four hours at a temperature of 0° or less. The crystals formed are filtered off, pressed, dissolved in the smallest quantity of water, say 25 to 30 per cent, exposed to a temperature of 10°, and left undisturbed for twenty-four hours. The whole solution will be found converted into a crystallized mass.

HæMOGLOBIN.—The production of hæmoglobin crystals is surrounded at times with more or less difficulty, owing to the rapidity with which the hæmoglobin decomposes. A simple method is to allow the blood to coagulate, express the serum, and separate the fibrin by filtration. Through this solution pass a current of oxygen for half-an-hour, and then carbonic acid gas for ten or fifteen minutes. Crystals may be readily obtained from the blood of the dog and other animals by adding alcohol in small quantities during the passage of the gas currents.

MAGNESIUM.—As an illuminant for photo-micrography this is not a new idea. It was used for this purpose by Dr. R. L. Maddox as far back as 1864, but owing to the expense of its production it never became really popular. Magnesium is prepared commercially from the melted chloride of electrolysis, or by metallic sodium, and, when heated either in air or oxygen it first glows and then burns with a bluish-white dazzling flame. The experiments of Bunsen and Roscoe have shown that the sun at its zenith has only 36.6 times more chemical brightness and 524.7 times more visual brightness than magnesium. It is therefore specially suitable for photographic purposes, and now that the price of the metal, either as bar, wire, ribbon, or powder is so low, there is every inducement to the photomicrographer to call in its aid.

DIATOMS.—To prepare photo-micrographs of diatoms, first photograph the diatoms with a magnification of not more than 100 diameters, then enlarge so as to obtain a photograph of 500 diameters, proper for photo-printing. The finest details are thus brought out, which otherwise are invisible to the eye in the smaller photograph. Even forgeries in legal documents can be discerned by using enlargement pictures, which microscopically are not visible if printed on bromide or velox paper.

FISH-TEETH.—The following method of preparing sections of the teeth of fish is suggested by Mr. A. Underwood, of the Leicester Square Dental Hospital. Sections of fishes' teeth should not be ground, but the jaws and teeth should be decalcified in a 5 per cent solution of chromic acid, or a 10 per cent solution of hydrochloric acid. After sections have been cut and stained, they should be well washed in distilled water, dehydrated for three minutes in absolute alcohol, cleared in oil of cloves, and mounted in Canada balsam. Carmine is the best stain for fishes' teeth.

FUNGI.—In collecting any fleshy fungi, care should be taken to obtain all the fleshy structure, as some of the most important characters are only to be observed in the basal parts. To remove the basal portion entire, a knife or small trowel should be employed. Specimens that are broken off short with the ground are seldom of much value for scientific purposes. Fleshy ascomycetous fungi can best be preserved in alcohol, but many of them may also be satisfactorily dried. It is well, when fungi gathering, to take a stock of tissue paper to wrap the specimens in. Each form should be wrapped up separately so as to prevent breaking, or soiling from contact with one another.

DEAD BLACK.—A good dead black for varnishing the interior of microscope tubes and cameras may be made by mixing two grains of lamp-black with just enough gold

size to hold the lamp-black together. Add the size drop by drop from a lead pencil. After the lamp-black and size are thoroughly mixed and worked up, add twenty-four drops of turpentine and work up again.

RADIOLARIA.—To the current issue of the journal of the Quekett Club Mr. A. Earland contributes an interesting article on the structure, distribution and life-history of the Radiolaria, illustrated by three plates from the Report on the Radiolaria of the "Challenger" Expedition.—*Knowledge.*

To KILL ROTIFERS.—At a meeting of the Manchester Society, Mr. M. L. Skyes contributed a note on the methods that Mr. C. F. Rousselet employs when preserving and mounting organisms so that they shall retain their natural forms with their colors, muscles, etc. Mr. Rousselet exhibited a number of microscopical preparations of Rotatoria at the International Zoological Congress at Cambridge, which claimed special notice for their beauty and the success of the methods he had adopted. Rotifera cannot be killed suddenly, by any known process without contracting violently, and losing all their natural appearance. To kill and preserve them with their cilia fully expanded and in their natural condition Mr. Rousselet first narcotizes them with a solution consisting of 3 parts of a 2 per cent solution of hydrochlorate of cocaine, 1 part of methylated spirits, and 6 parts of water. The Rotifers should first be isolated in a watch-glass and clean water, and a drop or two drops of the solution added at first; after five or ten minutes another drop should be added, and afterward drop by drop and very slowly until the animals are completely narcotized. They may then be killed and fixed by adding one drop of an eighth per cent to a quarter per cent solution of osmic acid. To clear from the solution they must be washed several times, and then transferred to a $2\frac{1}{2}$ per cent solution of formaldehyde, and

should be mounted in this fluid in hollow ground glass slips. The objects have all the appearance of living animals, the colors, internal structure, and outward form being beautifully preserved *in situ*.

MOULDS.—In observations on the microscopic life of Arctic regions, Dr. Levin states that air from numerous localities showed only a few moulds. In water from the sea-surface bacteria were always found, but in very small numbers—perhaps one thousand to a quart; while water from glaciers, snow streams, ice and melted snow, also gave evidences of bacteria in small numbers. In water from the deep sea these organisms were more abundant than on the surface. With the exception of a single species of bacterium found in one bear and two seals, the intestinal contents of the white bear, seal, shark, eider duck, and other Arctic vertebrates were absolutely sterile, but bacteria were almost invariably present in the lower marine animals. These observations on germ-free intestines are of special importance and interest, as they confirm the idea of Pasteur and a few others that bacteria are not essential to digestion.

REALGAR.—In his address to the Quekett Society, Dr. Tatham alluded to the difficulties attending the use of realgar as a mounting medium. Its high refractive index makes it most useful, but its disadvantages are many and serious. The fusion of the material which is necessary for the mounting process requires the application of great heat. This liberates intensely poisonous fumes, and frequently so distorts the valves of the diatoms that they are seldom found to lie flat on the cooling of the slide. The color of the finished mount is a deep yellow, and this seriously detracts from the value of the mount for critical examination. This last defect may be partially rectified by the use of suitably colored screens, of which a polished plate of bright blue glass has been found to be best adapted to aiding in the resolution of difficult tests.

"Zoology."—The current issue of the "Journal of the Linnean Society" contains, among other articles of interest to the microscopist, a contribution by Mr. H. Wagner on "The Eye Spot and Flagellum of *Euglena viridis*," and a paper by Mr. H. M. Bernard on "The Structure of *Porites*."

MAKING DIAMONDS.—Among the impurities that have been detected in calcium carbide are microscopic diamonds. These gems are so exceedingly small as to be of no commercial value, but they accentuate the fact that carbon in the crystalline condition can be produced artificially, and give reason for the assumption that some day it will be possible to produce diamonds of a size sufficient to be marketable.

MICROTOME.—A Cambridge Instrument Company is introducing an improved model of their well-known rocking microtome. Among the advantages that they claim for the new form is the possibility of cutting sections to any required degree of thinness without the risk of the sections either varying in thickness or of being torn on the upward movement of the object.

STRUCTURE OF EPIDERMIS.—In man and mammals, L. Ranvier has recognized seven distinct layers, which are described to the Royal Microscopical Society as *stratum germinativum*, *filamentosum*, *granulosum*, *intermedium*, *lucidum*, *corneum*, and *disjunctum*, in the order of their development. The limits are well defined, each layer having distinct physical characters and chemical reactions. These layers are not formed by special elements, however, and a cell originating in *stratum germinativum* becomes changed and passes into *stratum filamentosum* and so on through the series.

STRUCTURE OF METALS.—Mr. J. E. Stead has published the results of the work that he has recently done on the metals. Experience has made it easy to cut, grind, polish,

and etch ordinary metals and alloys, and specimens can now be prepared for the microscope in a few minutes. Mr. Stead's work has yielded some unexpected results. In a recent demonstration, pig-iron was shown to have its constituents gathered into separate centres, the carbides being in isolated silvery crystals, while the phosphorus and sulphur compounds were each distinctly separated. A brilliantly polished piece of white pig-iron, containing carbon, sulphur and phosphorus, was then heated until it became purple. Under the microscope the constituents were found to have diverse colors, the iron being of a fine sky blue, the carbides an orange color, the phosphides a pale brown yellow, and the sulphides a slaty blue. This method of identifying phosphides is a new discovery which will be of great value to iron manufacturers as a simple means of telling whether iron contains phosphorus. The microscope shows that alloys, instead of being homogeneous, as have been thought, are built up of various crystals, and is likely to prove of practical service to metal workers in many ways.—*Knowledge.*

Experiments to Determine the Cause and Dissemination of Texas Fever.

DR. D. E. SALMON.

[This article shows some of the limitations of microscopy in dealing with disease.—*EDITOR.*]

The first step toward revealing the nature of the disease was evidently to determine if it could be inoculated from animal to animal. If this question were decided in the affirmative, it would be possible, by continuing the inoculation experiments, to determine how widely the virus was distributed through the body, and with what secretions or excretions it was disseminated by the affected animal. It might also be possible to identify a micro-organism as the essential cause and to study its biology.

With these purposes in view, the writer, in 1879 and 1880, inoculated six head of cattle and drenched three with liquids that appeared most likely to contain the contagion. Two of these animals had an attack of fever, one being so seriously affected that it became quite weak and emaciated. In 1882 three more animals were inoculated, one of which became sick in ten days and died three days later of acute Texas fever. This was the first demonstration of the inoculability of the disease, and it proved that a mixture of blood and splenic pulp contained the contagion.

In 1886, Dr. Smith, in studying microscopic preparations from the spleen of an animal that had died of the disease, observed peculiar bodies in the red corpuscles which were suggestive of parasitic micro-organisms. In 1888 and 1889 further studies of these bodies were made, which led to the conclusion that they were protozoa. As the most prominent feature of the disease was found to be a breaking down and destruction of the red corpuscles, and as these parasites existed almost exclusively in the red corpuscles of the blood, there was some reason to think they might be the cause of the disease.

At this period, having completed the survey of the permanently infected district, the writer observed that this district corresponded almost exactly with the habitat of the tick (*Boophilus boris*), which was almost invariably found to infest the cattle that were capable of transmitting the disease. Taking this coincidence, with the strong belief held by many cattle men of experience, that the ticks had something to do with the production of the disease, it was determined to have this aspect of the question fully investigated. Dr. F. L. Kilborne, who was at that time in charge of the Bureau experiment station, was consulted and given explicit instructions to carry through one or more series of experiments with this object in view. The first experiments were made in 1889, and the result

was: (1) That Northern cattle pastured in a field with cattle from the infected district which were infested with ticks contracted Texas fever; (2) that Northern cattle pastured in a field with cattle from the infected district that were carefully freed from all ticks by hand picking did not contract Texas fever; (3) that Northern cattle pastured in a field where no cattle from the infected district had been, but over which had been scattered a large number of ticks, contracted Texas fever.

The result of these experiments was a distinct and positive advance in our knowledge of the disease. It was now known (1) that the disease was inoculable; (2) that the blood of diseased animals contained a microscopic protozoan parasite; (3) that ticks picked from Southern cattle and spread upon pastures were a means of communicating the infection.

It was next important to learn in what manner the ticks conveyed the contagion. From a medical point of view the most plausible theory was that the biting parts of the ticks became soiled with the blood of the Southern cattle, and that these contaminated ticks, migrating to susceptible cattle, carried the virus and inserted it when they began sucking blood from the latter. A study of the life history of the tick showed, however, that this theory was not consistent with the facts. The ticks do not leave one animal and go to another. When they are once upon an animal they remain there until they become mature, and then they drop off, lay their eggs on the surface of the ground, and die. There is no opportunity for this parasite to carry blood directly from the Southern to the Northern animal and inoculate it.

Another hypothesis was that with the blood sucked from Southern cattle the tick took into its body the virus of the disease, and that, when the mother tick died and became disintegrated upon the pastures, the contagion was liberated and the grounds infected. This supposition was en-

tirely demolished by experiments, which proved that the disease was caused by young ticks hatched from the eggs of the mature ticks which developed upon the Southern cattle, that is, the contagion is in some manner transmitted from the adult tick through its eggs to its progeny, and this progeny has the power of inserting the contagion into the circulation of the cattle upon which it happens to fasten itself.

These facts threw much light upon the propagation of the malady, but they were not sufficient to establish a scientific theory explaining the transmission. Indeed, it was yet to be proved that the Southern cattle carried the protozoa in their blood. Microscopic examination was not sufficient to decide the question. A few minute points were observed in the red corpuscles of Southern cattle, but these points were much smaller and far less numerous than the protozoa in sick Northern cattle. The Southern cattle, besides were in good health, and it seemed improbable that they harbored so deadly a parasite.

There was but one way to decide as to whether Southern cattle carried this contagion in their blood, and that was to inoculate susceptible Northern cattle with the blood of Southern cattle. This experiment was made, and it demonstrated that a comparatively small quantity of blood from a Southern cow, injected under the skin or into the veins of Northern cattle, produced an acute attack of Texas fever. In Northern cattle infected in this manner the protozoa appeared in the blood corpuscles with the same characteristics as when the infection occurred through the medium of ticks. There could no longer be any doubt that the blood of cattle from the infected district contained the contagion of Texas fever.

It was now important to decide how long Southern cattle carried this contagion in their blood after leaving the infected district. Again, it was necessary to resort to inoculation, as the microscope was powerless to decide. The

first experiments had been made with the blood of cattle immediately after they had been brought from the South. In the next experiment blood was used from an animal that had been away from the infected district seventy-four days. This also produced disease. In succeeding years experiments were made by inoculating with the blood of cattle that had been under observation, with no chance for reinfection, for one year, two years, three years, four years, five years, six years, and seven years, and in every case the disease was produced. It was concluded, therefore, that this contagion once introduced into the blood of cattle remained there in an active condition throughout the animal's life.

We were now in a position to understand and explain the principal features of this disease, that is, it was plain that cattle in the infected district carried in their blood the contagion of Texas fever ; that this contagion was in reality a protozoan organism called the *Pyrosoma bigeminum*, analogous to the parasite of human malaria ; that this parasite was transferred to susceptible cattle outside of the infected district by the Southern cattle tick, *Boophilus bovis* ; that Southern cattle, although carrying the contagion, were harmless unless infested by this particular tick ; that the Southern cattle carried this contagion in their blood for years after leaving the infected district, and would again be dangerous to other cattle if by any chance they were reinfested with the proper species of ticks. A study of the biology of the tick showed that the time required for the eggs to hatch depends upon the atmospheric temperature, and that all the mysteries of the propagation and incubation of the disease depended upon the hatching of these eggs.—*Report Agr. Dept.*

Wanted.—Earth containing diatoms from Redondo Beach for a European subscriber who offers cash, or, in exchange, Hungarian diatomaceous material from St. Peter. C. W. S.

Notes on Microscopy.

F. SHILLINGTON SCALES, F.R.M.S.

MOUNTING BOTANICAL SLIDES.—The best book for the beginner is Cross and Cole's "Modern Microscopy." Pages 114 and 144 to 154 deal specifically with the mounting of botanical specimens and are most clear and lucid, as might be expected from a mounter of Mr. Cole's experience. I would also recommend strongly to your notice Strasburger and Hillhouse's "Practical Botany" which, written primarily for the student of botany, contains eminently practical instructions in microscopical technique, and should be mastered by all who are interested in plant life.

THE MALARIA PARASITE.—Readers can hardly fail to be interested in the recent investigations of Major Ross, into causes and dissemination of malaria; investigations which appear to have solved the hitherto apparently insoluble problem as to the mode of life of the parasites to which malaria has now been traced, and to have given the final *coup de grace* to the old theory that it is connected with a certain condition of the soil. It is now placed beyond a doubt that malaria is due, and probably due only, to a parasite belonging to the family *Hæmacobidæ*, passing a stage of its existence in the stomach of certain mosquitoes, and by the bites of the latter infecting the blood of man. The life-history of these parasites has been completely followed by Major Ross in *Culex pipiens* and confirmed by others in *Anopheles claviger*. We would refer those who desire fuller information on this point to a paper by this investigator in "Nature" for August 3rd. The interest now lies in the question of the exact species of mosquito rather than that of the parasite. Major Ross, in more than one report has adduced facts in support of his strong belief that the dissemination of malaria is confined only to the comparatively rare "spotted-winged" mosquito, belonging to the genus *Anopheles*, and which has

been traced to two species in India and to one in Italy. Other and commoner forms of mosquito, such as the "brindled" and "grey" mosquitoes, are believed to be quite harmless, if painful, in their bites, though Koch has traced malaria in Tuscany to the bites of *Culex pipiens*. If this should be finally placed absolutely beyond a doubt it will be of the greatest importance not only to our military stations and camps, but to many crowded districts, towns and cities. Mosquitoes of the genus *Culex* breed in artificial collections of water, such as pots and tubs, cisterns, wells, and drains, but those of the genus *Anopheles* breed or are developed from larvæ or grubs found only in natural ponds and puddles of stagnant water in which green algæ are growing, and seldom in larger bodies of water such as tanks or streams, where they would be liable to be devoured by minnows, etc. Still, whether confined to the genus *Anopheles* or not, it seems certain that the flies breed in puddles, and are not of the common or domestic kind. If this be so, and it can be placed beyond question that these mosquitoes breed only in spots sufficiently isolated to be dealt with by public measures of repression, and that the malaria from which perhaps a large town is suffering can be abated by the filling up or otherwise treating with simple means a few small puddles, we have arrived at a result of investigation that cannot easily be over-estimated. It has already been found for instance, that a drachm of paraffin oil poured on the surface of a pool about a square yard in area has been sufficient to kill all the *Anopheles* larvæ in six hours. It was to solve these matters finally that the Liverpool School of Tropical Medicine sent out its recent well-equipped expedition to Sierra Leone, to follow up the work done by Major Ross in India, and to put the methods suggested to practical proof. Every assistance was given them by the Government, and as we understand that the expedition returned on October 7th to this country, well satisfied with

their labors, we may look for an interesting report. It may be noted, in conclusion, that only one member of the expedition, Mr. E. Austin, Assistant in Diptera, British Museum, became infected with malaria, through sleeping one night without mosquito curtains.

NAIDS.—The annelid *Nais proboscidea* is so called from its long and contractile prostomium. It is common amongst *Lemnae*, and its wonderful transparency makes it a most interesting microscopic object when living. The contractions and dilations of the vascular trunk can be easily observed, as also the constant movement of the prostomium, which though contractile, is not retractile. During the summer months the Nais frequently reproduce themselves by fission, a new individual being formed by constriction at one of the segments.

NOMENCLATURE OF NUMMULITES PERFORATA.—I have received a note from Mr. Fortescue W. Millett, the eminent authority on Foraminifera, with regard to the nomenclature of *Nummulites perforata*, which will be interesting to your readers studying these forms. He says:—"I have seen your paper in *Science-Gossip* on the forams of the Tocha Valley. *N. perforata* was not so named for the reason you suggest (*ante*, p. 165). The rude figure of *Egeon perforatus* being the *xlii. genre* of Montfort's *Conch. Syst. 808*, p. 167, is either a copy, or an imitation of Fichlel and Moll's figure of *Nautilus lenticularis* var. *Test. Micr. 1798*, p. 57, pl. vii. fig. h. It represents a shell with sinuous striæ, between which are tubercles or perforations, hence Montfort's name."—*Arthur Earland, 28 Glenwood Road, Catford.*

PREPARING AND MOUNTING WOOD SECTIONS.—Mr. J. D. King lays stress upon the necessity of using a good knife of the finest steel and the finest edge, as well as a thoroughly satisfactory microtome. We have found the ordinary English section-knife or razor barely strong enough for

this purpose, and a properly sharpened plane-iron is preferable. For embedding, hard paraffin should be used, as it shrinks less and holds the object more firmly. It will probably roll, but a light pressure with the ball of the finger when cutting will remedy this. The thickness of the sections is a matter of some importance, and the general tendency is to cut them too thin. If transparency is required, the sections must be bleached, and this requires care, as over-bleaching destroys the fibres of the section, and under-bleaching leaves a blotchy appearance. Mr. King suggests bleaching until the color is discharged from the wood, but no longer, and then a very thorough washing with water. In this connection we think an "anti-chlor" such as hypo-sulphite of soda might be used with advantage, but in any case the final washing must not be curtailed. The stains recommended are Delafield's hæmatoxylin, Bismark brown, and for double staining, Grenachers borax carmine and methyl or aniline green. The hæmatoxylin is the most generally useful, but is commonly made in too strong a solution. It is best to stain slowly in a comparatively weak solution, and when using the this reagent it is a good plan to wash finally in hard water from a tap, which has a tendency to fix the color. The Bismarck brown is useful for very delicate structure, or for large spiral or scalariform vessels. The double staining is best carried out by immersing the section in borax carmine for twelve hours or more, washing quickly, but well, in 50 per cent alcohol, placing for two or three seconds only in aniline or methyl green, washing as before, and then again staining in borax carmine till the red reappears, changing the supply of stain after the superfluous green is driven out. Mr. King recommends finally mordanting the section in alum cochineal. He gives the needed warning that 95 per cent alcohol will precipitate borax carmine, and that alcohol and hæmatoxylin must be kept separate. He recommends that glycerine jelly be

used as a mounting medium, but Farrant's solution, or Canada Balsam will give satisfactory results. The great difficulty will lie in getting rid of air-bubbles, especially "stowaways," and these must be carefully worked out with a dissecting needle under a dissecting microscope.

LOCUST DISEASE FUNGUS.—Reports in the *Agricultural Journal*, published by the Cape Department of Agriculture, give most interesting accounts of the success attained in many districts in the extermination of locusts by means of the locust fungus. The fungus is prepared by the Bacteriological Institute, Grahamstown, and any applicant can obtain a tube for the sum of sixpence. The reports show that in one case about a hundred locusts inoculated with the disease were distributed amongst a swarm, and next morning and within a few days after, large numbers of locusts were lying dead among the sand-dunes. The microscopical examination and subsequent experiments showed that they were unquestionably killed by the fungus. The growth of fungus from the dead locusts produced a fungus smaller in size, but more rapid in its growth, than the Government fungus. In another case young locusts were immersed in lukewarm water, in which the fungus had been mixed, and then set free. Three days afterwards rain fell, and on the fourth day small heaps of locusts were found about three miles away from where they had been immersed. Other districts in which no such means of inoculation were carried out were found to be much more infested with locusts. We shall await further reports with interest.

LIVERPOOL SOCIETY.—The thirty-first annual report is an interesting record of the Society's work during the past year. Seven papers, including the President's Inaugural Address, have been read, each paper being illustrated with the lantern, and at each meeting various objects were exhibited by the members. Two field meetings were held during the summer, which were well attended. The Presi-

dent's (Mr. W. T. Haydon's) address is printed in the report in full, the subject being "A Fresh-water Chert from Asia Minor, with observations on its formation and structure, together with some account of the Organic Remains found therein." This is an interesting paper, and suggests many equally interesting directions in which to carry out further investigation. The cherts referred to were "Worked Flints" found in a cargo of horse-beans from Smyrna. Several "acknowledged experts" at first pronounced these to be arrow-heads and scrapers, probably of the Neolithic Age ; and there are underlying ironies attaching to the subsequent determination that they were really teeth dropped from the old-fashioned threshing-boards still used in Asia Minor to remove the beans from their pods. These cherts were readily traced to their original source, and the paper above alluded to deals with their chemical analysis, and more especially the pains-taking microscopical examination by Mr. Haydon and his friends of the abundant vegetable and animal remains found therein. For this, and for conclusions drawn by the writer as to their process of formation, we must refer our readers to the original paper, the conclusion being that their origin is mainly diatomaceous.

BAKER'S NEW ACHROMATIC CONDENSER.—Mr. Chas. Baker has recently submitted for an examination his new achromatic condenser, which has a N.A. of 1·0, and an aplanatic aperture of about '9, being in this respect a great advantage upon the one hitherto listed and sold by this firm, which had an aplanatic aperture of only '65. The power is slightly higher than usual, but not enough to make it a higher-power condenser, whilst we notice with approbation its light and compact mounting. The condenser is fitted with the usual iris diaphragm and ring for stops, but a rotating ring within the latter would be a convenience. The price is \$18.

EMBEDDING.—We have not met with a mixture of stearine and naphthaline for embedding, nor can we find any reference to it in any text-book available, so are not able to give the relative proportions in which the mixture should be made. Can any reader furnish it ?

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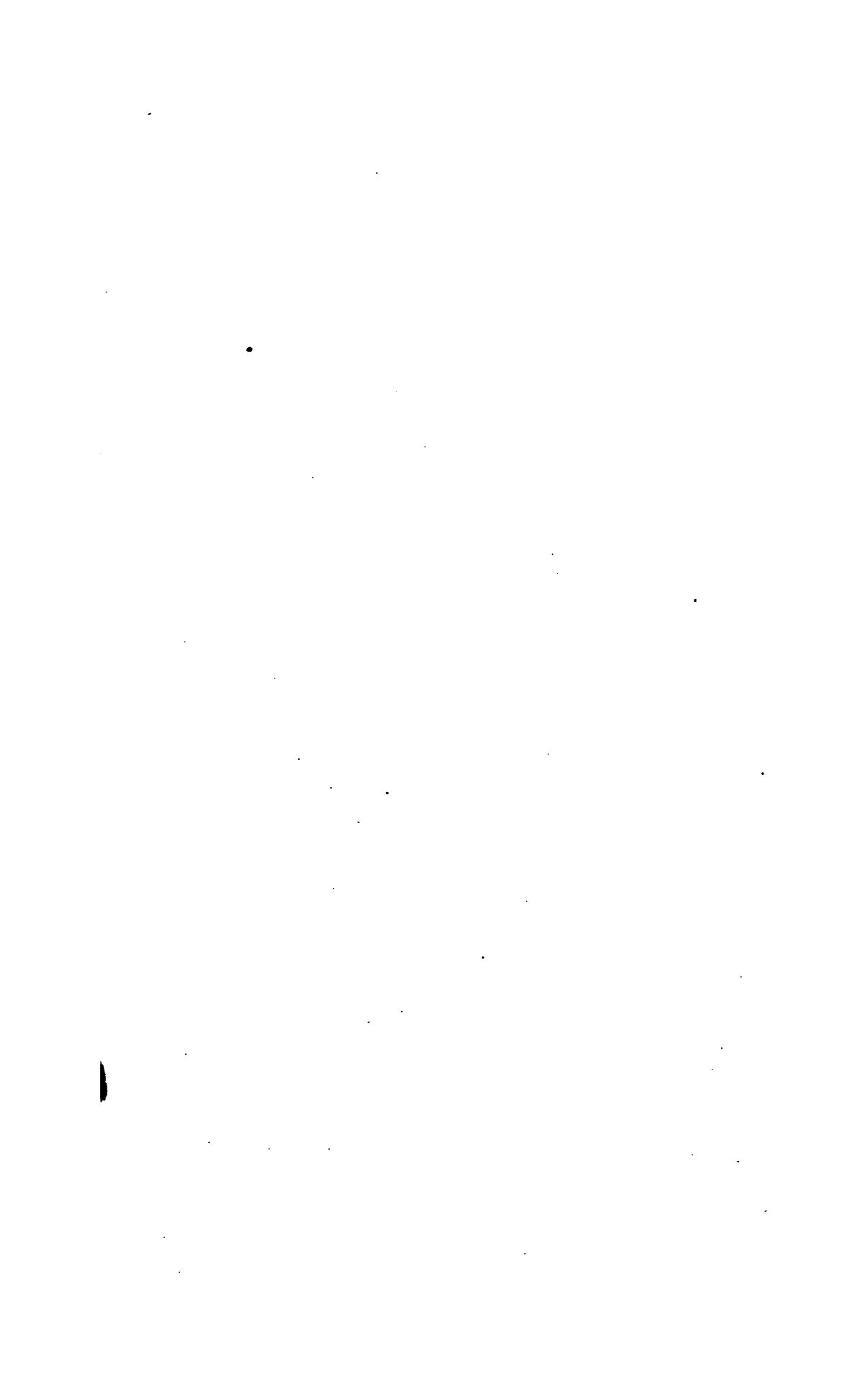
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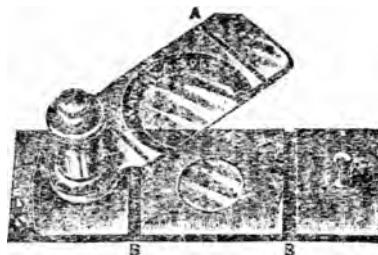


FIG. 1.—A A, Rubber bands in suitable grooves to carry cover glass; B B, grooves to receive rubber bands.



FIG. 2.—The same closed.

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CONTENTS.

Rogers' Compressor. Frontispiece.....	211
The Radiolaria. Edwards.....	211-217
Life in the Great Salt Lake. Talmage.	217-224
Peridiniae. Edwards.....	224-226
NOTES BY SHILLINGTON SCALES.—Postal Society; Preserving and mounting Rotifers; Baker's Microscopes; Ova of Lepi- doptera; Adjustment; Mounting; Slips; Dry Mounting; Cells; Richmond Park Ponds; Manchester Society; Spiders Wanted.....	226-236
MICROSCOPICAL NOTES.—The Great Salt Lake; Inspection of Pork.....	237-239

The Radiolaria.

ARTHUR M. EDWARDS, M. D., F.L.S.

I do not see why the Bacillaria or the Diatomaceæ, or in fact the diatoms, should claim so much of the notice of microscopists to the exclusion of other minute atomies. Perhaps they are more beautiful and perhaps it is the fact that they are, especially *Pleurosigma angulatum*, used as test objects for all microscope objectives of powers higher than an inch.

The Radiolaria claim a place at least in the cabinet of the microscopist, and I shall endeavor herein to establish their claim to furnishing a knowledge of the sarcode which forms as great a place in their composition as the pro-

toplasm of the Bacillaria does in its ; and perhaps of the sarcode or protoplasm of man himself. The elementary thing itself is but the sarcode or protoplasm of man in Radiolaria and in Bacillaria, and of Foramenifera too. Let this be distinctly understood. They are one in composition, and though man has something else to reason with, a Radiolarian or a Bacillaria or a Foramenifera has likewise intelligence to work with. Bacillaria, Radiolaria, Foramenifera and man are but parts of the great fabric of nature and man is no more entitled to consideration than the most minute Navicula, *Podocystis* or *Globigerina*.

The Radiolaria form an order in the phylla of the animal kingdom, at least that is the way they are classed by most naturalists now, but they are Protista according to the ranking of Hæckel. Whatever they be, Protista or animal they are low down in the scale of being. They comprise a vast number of Rhizopods, in which the sarcode body consists of a central protoplasmic mass, enclosed in a porous membranous or chitinous capsule, which at times is surrounded by a thick layer of sarcode. The introcapsular sarcode contains a central or nucleus, and the pseudopodia have the form of slender radiating filaments, which rarely anastomose with one another. As a rule, the protoplasmic body secretes a radially disposed skeleton composed of silica, or of a silicate, or of a horny substance (acanthine). A Radiolarian looks like the ivory balls the Chinese make, only they are transparent and glossy, so that these natural objects are more beautiful than any handmade thing. Some of the balls have a spine sticking upwards and three spines sticking downwards. While the sphere itself is marked with openings which are more or less hexagonal in appearance all of the clearest crystal. This is known as *Podocystis*. There is another which is like a disc or wheel the spokes of which are continued as spines beyond the tire, and the tire is separated several

times. This is *Stylodictya*. There is another formed by crystal hexagons united in two spheres open below and closed above and ending on a spine. This is *Encyrtidium*, but they may appear almost endless in form. They are not marked so finely as the *Bacillaria*, in fact they are not so small, but they are as beautiful in form. Hæckel classifies them as follows :

1. **SPUMELLARIA**.—Capsular membrane perforated by innumerable fine pores. Fundamental form originally spherical, skeleton silicious or in some cases absent. No dark pigment-body (phæodium) in the extra-capsular sarcode.

2. **ACANTHARIA**.—Capsular membrane perforated by numerous fine pores, fundamental form originally spherical. Skeleton composed of "acanthine." No dark pigment body in the extra-capsular sarcode.

3. **NASCELLARIA**.—Capsular membrane perforated by a porous area or by one single large opening divided into numerous very fine pores. Fundamental form originally egg-shaped. Skeleton siliceous. No dark pigment-body (phæodium) in the extra-capsular sarcode.

4. **PHÆDORIA**.—Capsular membrane double, perforated by a simple main opening prolonged into a tube, commonly with one or two small accessory openings. Fundamental form originally egg-shaped. A dark pigment-body (phæodium) is constantly present in the extra-capsular sarcode. The skeleton is silicious, being usually composed of a compound of silica with some organic substance, but in other instances (*Dictyocha*) consisting of pure silica.

It will be necessary to say here something about the form known as *Dictyocha*. When searching the rocks that make up the Oligocene tertiary and also, more rarely, examining the sea-mud that comes from the deep waters of the ocean, the observer comes across certain strange objects, siliceous in chemical composition and microscopic in

size. He does not know where to place them. They are rocky it is true but they are not rock as usually known. They are organic, that is to say, they plainly, when alive, have organs. Perhaps they are animal, perhaps vegetable and perhaps neither animal nor vegetable. He determines that they belong to that wonderful kingdom the Protista of Hæckel. He looks in his books to see what they are called and perhaps he will find what they are. Thus he discovers that they have been described by Ehrenberg in 1838, (Mont. d. k. Preuss. Akad. d. Wiss. Berlin, p. 128), who made no less than sixty species, thirty-five living and twenty-five fossil, and he described them from portions also, the siliceous pieces: as if a species can be described and formed from a broken bone alone! But in fact such things have been done. Ehrenberg first observed single pieces of the Radiolaria, fossil in the tertiary rocks and supposed them to be the siliceous carapace of a Diatom, a Bacillarian, and gave it the following diagnosis: "Dictyocha e familias Bacillariaceum. Lorica simplex univalvis silicea, laxe articulata-ant stellulata." On one view, the most common, it is like four festrated pieces, joined together with four spines projecting outwards and four spines projecting inwards. On another view, we see that they look like little hats of skeleton appearance with a spine projecting upwards. They have not markings like the Bacillaria and are therefore not members of that family. But Diatoms were animals when Ehrenberg named them and included anything bizarre which he found.

Hæckel in his Monograph of the Radiolaria, 1862, page 271, places them there, and they are destined to remain until someone shall find out something more about them. The greater part of Ehrenberg's sixty species cannot be retained but Hæckel describes twelve species. He gives one form which he says is cosmopolitan, *Dictyocha stapedia* but this is *D. fibula* of Ehrenberg, 1839.

As regards their distribution in space, the Radiolarians are exclusively marine, and are found in all seas and all depths. I have seen one *Dictyocha fibula* in the brackish water where it became fresh in the Passaic River at Belleville, N. J. But they are commonly floating organisms, and they are often present in enormous numbers so that they can be easily got and studied, but in the warm seas I have not found them except in the case mentioned above in this latitude. Many are pelagic, and inhabit the surface waters of all oceans soever. Others are abyssal and are confined to great depths in the sea; while others again, are "zonarial" and confined to particular bathymetrical horizons between the surface and the bottom. Over large areas of the deep sea, principally at depths of from 2,000 to over 4,000 fathoms, the bottom is found to be covered with extensive deposits, hence called "Radiolarian ooze." This deposit is a siliceous mud, with little calcareous matter, which is composed more or less largely of various Radiolarians. The skeletons of Radiolarians are, however, also present, in smaller or greater numbers in many of the marine deposits which are formed at comparatively limited depths.

As regards their distribution in time, Radiolarians are abundantly represented by fossil forms, which are now known to have high antiquity. Their past history is the Acantharia in which the skeleton is not siliceous but composed of acanthin and they are wholly unknown for that reason in a fossil condition. This is likewise the case with the whole group of Phæodaria, in which the skeleton is composed of silicate of carbon, with the single exception of the small group represented by *Dictyocha* and its allies in which the skeleton is purely siliceous. This genus belongs to the Upper Chalk, and is represented in Tertiary deposits and in recent seas. Until recently Radiolarians have only been detected in the fossil condition in deposits of Kainozoic and Mesozoic age; and our knowledge of

Palæozoic types of Radiolarians is still very incomplete. Dr. Rusk gives various types of Polycystina in rocks as old as the Silurian, even the Cambrian. M. Cayeux has found them also in the Silurian. The remains of Radiolarians have been indicated as occurring in the Carboniferous Limestone of England where they are known as *Calcisphæra*. These are composed of carbonate of lime but were originally siliceous and were changed.

In the Mesozoic system they are also found. From the Jurassic system in particular, numerous fossil Polycystina have been described by Zittel, Dunikonski and Rust. In the marls of the island of Barbadoes, which are placed in the Miocene, but should be Oligocene, they are found in abundance, also at the islands of Trinidad, Hayti, and Cuba and the recent seas thereabout. Many of the Jurassic Radiolarians occur in jasper, flint or chert, but they are especially abundant in what have been termed "Radiolarian quartzes." They are present in this at Monterey, Cal. They are considered by Hæckel as of the nature of the "silicified deep-sea Radiolarian oozes." They are found as "Radiolarian coprolites" in the Lias of Hanover. The Barbadoes earth is well known to microscopists as are the "tripoli" of Sicily, Calabria, Greece and Algiers. Another deposit of the same nature is the tripoli or Radiolarian clay of the Nicobar islands, which rise to an elevation of about 2,000 feet above the level of the sea and is probably of Miocene or Oligocene age. They are found in all quarters of the globe where Tertiary rocks or clay are, and present the spectacle of a vast continent or uprising which bear forms exactly the same as one that was recently found in the Lower Silurian. The Radiolarians existed then without being evoluted. Lately, and in fact in November, 1895, Dr. C. J. Hind has shown that Radiolaria are common in the Lower carboniferous measures of the Devonian age in Devonshire, England, and sends me a paper on the Radialarian rocks of that region.

It was in 1851 when engaged in studying the minute animals of the sea brought home by H. M. S. "Rattlesnake" Prof. Huxley came across the peculiar gelatinous bodies which he called *Thalassicolla*, signifying sea-jelly. They were common in the tow-net and are formed of extreme simplicity which made it extremely difficult to place them, that is to say to classify them in the animal kingdom. They are a colorless, transparent, gelatinous mass, spherical, elliptical or elongated in form or contracted like an hour-glass in one or more places. They vary in size from a mere speck up to an inch in length, without contractility or power of motion, but float passively upon the water. Such were the masses of jelly which he saw and named *Thalassicolla*. The "species" as he called them were *T. punctata* and *T. morum*, but they proved afterwards to be Radiolaria, and the observation of *Thalassicolla* brings us to the difficulty of classifying objects. Huxley, one of the greatest classifiers of the modern school, did at first find it difficult to classify them at all. And now we confess it is difficult to classify animals or vegetables as such. We must rank these simple organisms as *Protista*.

Life in the Great Salt Lake.

DR. J. E. TALMAGE.

The popular literature of the day persists in asserting that no living thing exists or can exist in the dense brine of the Great Salt Lake. There is little excuse for the perpetuation of such an error; yet cyclopedias and school geographies and magazines continue to reiterate the false statements. It is readily seen that the conditions prevailing in the lake are not favorable to the existence of the ordinary aquatic forms of life; and that cases of adaptation to life in the brine would naturally be rare.

Of animals but few species have been found in the lake, but of these few two are represented by swarming num-

bers. Among the animal forms already reported as common to the lake, the writer has confirmed the presence of four:—(1) *Artemia fertilis*, Verril; (2) the larvæ of one of the Tipulidæ, probably *Chironomus oceanicus*, Packard; (3) a species of Corixa, probably *Corixa decolor*, Uhler; (4) larvæ and pupæ of a fly, *Ephydria gracilis*, Packard.

The larvæ of the *Ephydria* are found in abundance amongst the algæ that strew the shores or appear as surface patches in the shallow parts; while the mature insects, as small black flies, swarm along the shores where conditions have proved favorable for their development. The larvæ of the tipula may be taken anywhere near shore during the warm months; and the pupa cases of both species are often washed ashore in great numbers, where they undergo decomposition with disagreeable emanations.

Of the animals, the *Artemia fertilis* (or *Artemia gracilis*) commonly known as the brine shrimp, exists in greatest numbers. They are tiny crustaceans, seldom exceeding one-third inch in extreme length. They may be found in the lake at all seasons, though they are most numerous between May and October. I have taken them in the midst of winter, when the temperature of the water was far below freezing point; it will be remembered that the concentrated brine of the lake never freezes. The females greatly preponderate: in fact, during the colder months it is almost impossible to find a male. In the latter part of the summer the females are laden with eggs, from four to sixteen having been repeatedly counted in the egg pouch. The males are readily recognized by the very large claspers upon the head. The shrimps are found near shore during calm weather, but rain or wind drives them into the lake. At times they congregate in such numbers as to tint the water over wide areas.

They are capable of adapting themselves to great variation in the composition of the water, as must necessarily be the case with any tenant of the Salt Lake. I have

specimens of the *artemiæ* gathered from the lake in September 1892, and the water then taken showed on analysis, 14,623.23 grains of dissolved solids to the imperial gallon, the greater part of this being salt. Indeed, I have captured the creatures in the evaporating ponds of the salt works, where the brine was near its point of saturation.

It is not difficult to accustom them to a diluted medium; I have kept them alive for days in lake water diluted with 25, 50, 80 and 90 per cent fresh water, and from eight to eighteen hours in fresh water only. Of course the changes from brine to fresh water were made gradually, though a sudden transfer from the lake brine to fresh water or even to distilled water is not followed by speedy death. On the contrary, the creatures live for hours after such sudden change, with few signs of discomfort or inconvenience except their inability to rise in the water of low density.

The ability of the shrimps to withstand the effects of rapid dilution of the medium is surprising if we assume that their tissues are ordinarily impregnated with the salt of the lake brine. The violent osmosis between the dense fluids of the tissues and the fresh water without would appear to insure disruption. It is possible, however, that the tissues do not absorb the brine in its entirety; indeed, if the shrimps just taken from the lake be subjected to a single quick rinsing with fresh water, they are but slightly salty to the taste.

During a cruise upon the lake in September 1892, our party found the crustaceans swarming in the open water. When near the middle of the lake, with a small tow-net we gathered a quart of the shrimps in the course of a few minutes. Thereupon we resolved upon an experiment the subsequent recital of which has shocked the gastronomic sensibilities of many friends. Reasoning that the bodies of the *artemiæ* are composed largely of chitin, we concluded that the question of their palatability was at least worthy of investigation. By a simple rinsing with fresh

water the excess of lake brine was removed, after which the shrimps were cooked with no accompaniments save a little butter and a suggestion of pepper. They were actually delicious. If the shrimps could be caught and preserved in quantity, I doubt not they would soon be classed as an epicurean delicacy. Repeated washings for five minutes removed the brine so completely that salt had to be added to make the dish palatable.

As to their food—in captivity they live upon meat, bread, or vegetables, in fact upon almost anything in the nature of food; and they are not slow in attacking the bodies of their own dead. In the lake they probably subsist upon the organic particles brought down by rivers, upon the algæ which flourish about the shores, and upon the larvæ and pupæ of the insects tenanting the water.

The mounting of specimens of the brine shrimp for permanent microscopical use requires considerable care and some modification of the ordinary procedure. Most of the common mounting media cause the delicate structure to become distorted, or produce such a degree of transparency as to render the object invisible. A method which has given the writer good results consists in mounting the specimen in a preparation of lake brine with corrosive sublimate and an alcoholic solution of carbolic acid. To this fluid, placed upon the slide, the living *artemia* is transferred directly from the lake brine; the creature dies quickly, and in so doing spreads itself most perfectly. While objects so prepared are of admirable arrangement and definition as temporary mounts, the structure is liable to break down after a lapse of months.

A better permanent result may be secured as follows: Place the *artemia* in Peryeni's fluid; they will be quickly killed, and will be hardened by the action of the fluid in from 12 to 20 hours. They should then be transferred to alcohol, the strength of which should be increased by degrees, beginning with 40 per cent and running to 95 per

cent. The structure will take some of the analine stains quite readily ; it may then be carried through absolute alcohol with phenol, then through phenol and turpentine, and be permanently mounted in balsam.

In point of zoological classification it may be said that the brine shrimp is a crustacean, and is generally referred to the order *Phyllopoda* one of the divisions of the sub-class *Entomostraca*. In all phyllopods except those of the highest family of the order, a carapax covers the greater part of the body. To this highest family—the *Branchipodidae* the *artemia* belongs.

The *Artemia* is distinguished from a nearly allied form, the *Branchinecta* in the following particulars: *Artemia* possesses eight abdominal segments ; the second pair of antennæ or claspers, which are highly developed in the male, and flat and of triangular shape in the second joint; the ovisac of the female is short. *Branchinecta* has nine segments composing the abdomen ; the claspers are simple and cylindrical ; the ovisac is long and slender.

Commenting on the structural and other relations between these two forms, Prof. J. S. Kingsley says ; "Under ordinary circumstances these [differences] would be considered as of generic value : but what shall we say when we know the results of the observations and experiments of the Russian naturalist, Vladimir Schwankewitsch ? Condensed from his account these were as follows : In 1871 the spring flood broke down the barriers separating the two different lakes of the salt-works near Odessa, diluting the water in the lower portion to 8 degrees Baume, and also introducing into it a large number of the brine shrimp, *Artemia salina*. After the restoration of the embankment the water rapidly increased in density, until in September 1874, it reached 25 degrees of Baume's scale and began to deposit salt. With this increase in density a gradual change was noticed in the characters of the *artemia* until late in the summer of 1874,

forms were produced which had all the characters of a supposed distinct species, *Artemia muehlausenii*. The reverse experiment was then tried. A small quantity of the water was gradually diluted, and though conducted for only a few weeks, a change in the direction of *Artemia salina* was very apparent.

"Led by these experiments he tried still others: Taking *Artemia salina*, which lives in brine of moderate strength, he gradually diluted the water, and obtained as a result a form which is known as *Branchinecta shaefferi*, the last segment of the abdomen having become divided into two. Nor is this change produced by artificial means alone. The salt pools near Odessa, after a number of years of continued washing, became converted into fresh water pools, and with the gradual change in character, *Artemia salina* produces first a species known as *Branchinecta spinosus*, and at a still lower density *Branchinecta ferox*, and another species described as *Branchinecta medius*."

Observations on the artemia of the Salt Lake under conditions of slow increase or decrease of the brine density indicate the occurrence of changes in structure, but no long continued experiments of conclusive results have been reported.

The artemia is interesting to the zoologist as furnishing an example of parthenogenesis, i. e., reproduction by means of unfertilized eggs. Siebold of Munich has investigated this subject, and he announces that with the entomostracans, *Apus* and *Artemia*, this parthenogenic reproduction is common. He reared several broods composed entirely of females; yet from these, eggs were produced which hatched vigorous young. Packard treats parthenogenesis as a modified process of reproduction by budding.

The eggs of the artemia are capable of sustaining long continued drought without losing their vitality. Eggs have been sent in mud from the Salt Lake to Munich,

Germany, where they have been successfully hatched by Sibold. It would be interesting to determine whether the fertilized eggs and those of parthenogenetic origin are of equal vitality under unfavorable conditions. In the light of known facts concerning reproduction among other forms, it would be reasonable to expect that unfertilized eggs would prove less able to withstand vicissitude.

The following remarks by Gilbert regarding the brine shrimp are of interest: "Packard ascribes the phenomenal abundance of the *Artemia* to the absence of enemies, for the brine sustains no carnivorous species of any sort. The genus is not known to live in fresh water or water of feeble salinity, but commonly makes its appearance when feebly saline waters are concentrated by evaporation. It has been ascertained that a European species takes on the characters of another genus, *Branchinecta* when it is bred through a series of generations in brine gradually diluted to freshness; and conversely, that it may be derived from *Branchinecta* by gradual increase in the salinity of the medium. It is found, moreover, that its eggs remain fertile for indefinite periods in the dry condition, so that whatever may have been the history of the climate of the Bonneville Basin, the present occurrence of the *Artemia* involves no mystery. During the Bonneville epoch its ancestors may have lived in the fresh waters of the basin, and during the epoch of extreme desiccation, when the bed of Great Salt Lake assumed the playa condition, and was dry a portion of the year, the persistent fertility of its eggs may have preserved the race. Or, if the playa condition with its concomitant sedimentation was fatal to the species, it may be that the alternative fresh water form survived in upper lakes and streams of the basin so as to re-stock the lower lake whenever it afforded favorable conditions."

The lake flora has received even less attention than has been bestowed upon its limited fauna. The existence of

plant-life in the water is indicated by the abundance of animal life therein, and examination confirms the inference. The shore waters show an extensive vegetable growth, principally, perhaps entirely, of algæ. A number of species seem to be indicated from the widely varying colors of the vegetable masses, and three have been recognized. Diatoms have been found in the brackish waters of the playa-pools ashore, and diatomaceous deposits make up part of the old lake beds.

Much has been said at different times as to the possibility of adapting fish to a life in the lake. In the absence of experimental data it would be rash to conjecture; though it would appear unlikely that fish could thrive in such a brine. Yet the fear expressed, that even if fish could be accustomed to the lake water they would starve unless artificially fed, is unfounded, for the waters contain an abundant food supply—crustaceans, insect larvæ and pupæ, and algæ. The fauna and flora of the Great Salt Lake are subjects inviting thorough investigation.—*New book entitled The Great Salt Lake.*

Peridinieæ.

ARTHUR M. EDWARDS, M. D., F. L. S.

Many besides myself have been much puzzled to place the Peridinieæ as an order of microscopic things. For one may call them things, until he can place them understandingly in the vegetable or animal kingdom. They are not Protista, at least they do not conform to the classification which Haeckel has placed Protista in; and yet as George Murray says in his "Introduction to the Study of Sea weeds," London, 1875, "judged by our present knowledge of this order, it occupies a position on the borderland between the plant and animal kingdoms, while the balance of evidence certainly leans towards our regarding them as plants." That is to say, one who is a botanist thinks they are plants, whilst one who is a zoologist

places them in the animal kingdom. One who is neither a botanist nor a zoologist, mearly a student of life (a biologist) is inclined to pause ere he classifies them at all.

Some of the forms that are classified with the Peridinieæ, namely Ceratium seem certainly to be plants. They are always free, never attached, except one to the other. Ceratium is found in fresh water and also in the sea. They appear as a motile form or phase and assume a resting stage. Their reproduction is always by cell-division. It is reported that conjugation takes place, but this is doubtful. They are made of a substance which is nearly related to if it is not cellulose. In fact cellulose when examined chemically is made from wood and that is C-6 H-10 O-5 expressed in chemical formulæ. But that substance is present also in the animal as well as the vegetable kingdom; in fact, in the Protistan kingdom, if we may so express it.

The thallus of the Peridinieæ is also impregnated with calcium carbonate. It is not so in Ceratium which shows how loosely they are classified. They are placed in the animal kingdom or in the vegetable or in the Protistan kingdom, loosely however. What then is a kingdom which thus allows objects to be placed in it or out of it? Kingdoms must die for objects like the Peridinieæ must stand.

Murray says: "In some of the fresh-water forms, an animal-like has been described, and green algæ (*Chlamydomonas* and others) are stated to have been ingested and partly digested. In such forms no chromatophores occur, and the starch present must be the fruit of such captures. It is apparent from such observations, and from others, that very diverse organisms have been gathered together under this order."

"Reproduction is always by division, and since it appears to occur in the most varied way among the fresh-water forms—in some cases during the motile phase, in others during the resting stage and after encystment—

this fact lends support to the view that the order is not very coherent."

"The geographical distribution of the marine forms is principally in the temperate waters of the ocean, more abundantly in coastal waters than far from land. Vast banks of Ceratium occur on the British coasts, causing the waters to be brightly luminous at night. They form, with the Diatoms, a very large proportion of the primary food of marine animals. The occurrence of Ceratium tripos in Catenna has been observed only in the open ocean, far from land. In coastal waters they occur separately."

The genus *Pyrocystis* contains two very different forms. One is a sphere and the other a form made of two conical pyramids attached by the bases of the cones, something like a *Closterium*. The first, J. Murray calls *Pyrocystis noctiluca* and the latter *P. fusiformis*. The first is luminous at night. It is a tropical form, and to it was attributed the most brilliant displays of luminosity of the sea during the Challenger Expedition. We must remember that when it was first found, Dr. John Murray thought it was a diatom and so announced it. But it does not have any hard skeleton or markings, though from that it cannot follow that it is not a diatom for some diatoms are known which have no hard skeleton or markings. But it is not a diatom at any rate and is ranked until its place can be determined among the Peridinies.

Notes on Microscopy.

F. SHILLINGTON SCALES, F.R.M.S.

POSTAL MICROSCOPICAL SOCIETY.—During the summer of 1873, a letter appeared in *Science-Gossip* suggesting that if twelve gentlemen could be found willing to co-operate in forming a little club for the circulation of microscopic slides, and notes thereupon, it might lead to a very pleasant and profitable interchange of thought and study. This letter was replied to by the late Mr. Alfred Allen, of

Bath. The scheme met from the very first with much more support than had been anticipated, a code of rules was quickly drawn up, and in September of that year the Society came into existence with a roll of 36 members. Mr. A. Atkinson, of Brigg, the writer of the original letter, was fittingly made the first President, and was succeeded in due course by the late Mr. Tuffen West, with whose name every microscopist is familiar. By that time the Society numbered, we believe, over 100 members, and the membership subsequently increased in an even greater degree. The leading spirit of the Society was, however, Mr. Allen himself, and in 1882 he added largely to the usefulness and status of the Society by publishing at monthly and quarterly intervals the well-known "International Journal of Microscopy and Natural Science," which, besides acting as the Society's medium, contained many valuable scientific papers. It is understood that the journal was not self-supporting, but Mr. Allen himself willingly undertook its publication until failing health obliged him to discontinue its issue in 1897, after fifteen years of labor thereon. Mr. Allen's death in the following year (March 24, 1898) was a severe blow to the Society, and it was for a time, we believe, practically in abeyance, until the appointment of a new Hon. Secretary, Miss Florence Phillips, commenced what we hoped will prove to be a new lease of life. Unfortunately, since Mr. Allen's death and the cessation of his journal, the Society has had no recognized medium for publishing the many interesting notes that are entered in MS. memorandum-books that have circulated with the slides sent round amongst the members. In consequence, the Editor of *Science-Gossip* communicated with the Secretary and President of the Society, and offered to place at its disposal a portion of the space in this journal for the publication of such notes. This suggestion has met with approval, and it is intended to occupy at least one page monthly, in the section set apart

for microscopy, for notes extracted from the Postal Microscopical Society's memoranda. It is hoped that these will contain information as interesting to our readers as to the members of the Society, and will lead to profitable discussion in our columns. Before closing this announcement we desire to draw the attention of our readers, who are workers in the field of microscopy, to the many advantages accruing to membership of the Postal Microscopical Society. Full particulars may be obtained from the Honorary Secretary, Miss Florence Phillips, "Haford Euryn," Colwyn Bay, North Wales.

METHOD OF PRESERVING AND MOUNTING ROTIFERA.—The following is Mr. Rousselet's method, communicated to the Manchester Microscopical Society by Mr. Mark L. Sykes, F. R. M. S.: "Rotifera cannot be killed suddenly by any known process without contracting violently and losing all their natural appearance. To kill and preserve them with their cilia fully expanded and in their natural condition, the animals should first be narcotized with a solution consisting of 2 per cent solution of hydrochlorate of cocaine, 3 parts; methylated spirit, 1 part; water, 6 parts. The rotifers should first be isolated in a watch-glass and clean water, and a drop, or two drops, of the solution added at first. After five or ten minutes another drop should be added, and afterwards drop by drop and very slowly, until the animals are completely narcotized. They may then be killed and fixed by adding one drop of a $\frac{1}{2}$ per cent to $\frac{1}{4}$ per cent solution of osmic acid. To clear from the solution they must be washed several times in clean water, until all the acid is completely removed. The rotifers must then be transferred to a $2\frac{1}{2}$ per cent solution of formaldehyde ($2\frac{1}{2}$ per cent of commercial, 60 per cent formalin, and $37\frac{1}{2}$ per cent of distilled water), and should be mounted in this fluid in hollow-ground glass slips. The cells must be well secured after mounting by several coats of cement. The process requires a little practice,

and great care should be taken that the animals are always in fluid, and not allowed to become dry in the process of mounting ; but the results are excellent, the objects having all the appearance of living animals, the colors, internal structure, and outward form being beautifully preserved *in situ*."

BAKER'S PLANTATION MICROSCOPE.—This is a cheap microscope designed for use by planters, missionaries, and others who have no practical acquaintance with the microscope, for the detection of the ova of intestinal parasites so common in men and animals in the tropics. It is accordingly simplified to the last degree ; there is one objective and eyepiece, giving a total magnification of 150 diameters, and the focussing is done by rotating the optical tube, which gives a vertical movement by means of a spiral slot and pin. There is a mirror, but no draw-tube, fine adjustment, or condenser, and the stand is a plain non-inclinable one. It fits into a tin case $9 \times 2\frac{1}{2} \times 2\frac{1}{2}$ inches, which contains also a supply of glass slips and covers, together with a sheet of printed instructions illustrating the eggs of Ankylostome, round and whip worms, Bilharzia and Distome ringeri, also of *Amœba coli* and Trypanosomes. We do not know what demand there may be in the tropics for an instrument of this sort, but it is certainly designed to stand the maximum of bad usage without ill-effect, and should prove sufficient for its purpose. We would scarcely recommend it, however, for any other than the purpose for which it is designed. The price complete is only \$11.00. It was recently exhibited before the Royal Microscopical Society.

BAKER'S R. M. S. MICROSCOPE.—Mr. Charles Baker has recently brought out a new microscope, especially designed for advanced workers, which both in design and workmanship deserves notice in these columns. The stand is of the solid tripod type, which, whilst giving nearly as firm a base, even in the horizontal position, as the true

tripod, is in some respects preferable to this latter form in the greater facility afforded for getting at the sub-stage adjustments when the microscope is used vertically. The limb is of the "Jackson" form with lever fine adjustment, than which we have found none more sensitive or serviceable. Each revolution of the milled head gives a movement of 11 millimetres (1-225 inch). The body has two draw-tubes, giving a variation of tube length from 120 to 250 millimeters, thus enabling objectives corrected for both the short and the long tube to be used at will. Both draw-tubes are graduated in millimeters, and the lower one is actuated by rack and pinion; a very useful addition when adjusting objectives so as to correct them for different thicknesses of cover-glass, especially in view of the growing tendency to make such corrections by this means instead of by the provision of a correction collar to the object itself. The body is of a large diameter that should lend itself to photography, and the eyepieces are of the new R. M. S. No. 3 standard size. There is a mechanical stage giving a movement of 25 millimetres in either direction, and graduated to half millimetres, and the stage is capable of rotation for about 280° . The top plate is provided with three adjustable stops for 3 inch x 1 inch and 3 inch x $1\frac{1}{2}$ inch slides with a view to greater facility in recording positions, and if required a large flat plate is available. The substages is of the usual form with centering screws, coarse and fine adjustments, the latter being exceptionally neat and so conveniently placed that both adjustments can be controlled without shifting the hand. There are the usual mirrors. All the fittings are sprung, and have adjusting screws to compensate for wear. The price of the stand alone, without case, is \$83.00.

OVA OF LEPIDOPTERA.—Recently we had the opportunity of carefully examining some hundreds of water-color drawings of British Lepidoptera. They were the work of Mr. E. Wheeler, of Queen's Road, Clifton, near Bristol,

who had faithfully delineated under the microscope the external structure and markings. As in most cases he had made drawings at various periods of the development of the embryo within the egg, this study proves to be one of much interest, as is also the ease with which butterflies and moths may be classified by the external structure of their eggs.

ADJUSTMENT.—If the microscope requires adjustment, these adjustments should be made with the utmost care. Most microscopes by our best English makers have the wearing parts sprung so that the adjustments may be readily effected, but even then a little attention to the tools with which the work is done may be recommended. The screwdriver, for instance, should be in good condition. It is well also to bear in mind that the lacquer on the brass-work of the microscope, placed there not so much for appearance as for the prevention of oxidization, is destroyed by alcohol. Finally, our advice to the beginner who may wish to oblige a friend by lending him his microscope is—don't!

MOUNTING.—The microscope has become quite an art, if not a science, and the list of reagents, stains, and media used for special purposes would be quite a formidable one. Fortunately the requirements of beginners and amateurs, especially those for whom we are now writing, are much more easily dealt with, and we shall confine ourselves to the simplest and most commonly used methods, trusting that as knowledge grows and experience comes with it, the beginner will learn more of such advanced methods from works dealing with the subject.

It is of course only with very low powers, and when the nature of the investigation admits of it, that an absolutely unprepared and unarranged object can be examined. For this purpose a pocket-lens is infinitely preferable to the compound microscope with all its complications and refinements. For examination with the latter instrument

even opaque objects require to be properly displayed, whilst objects to be examined with transmitted or direct light—that is, by means of light that passes through the object—require very careful preparation beforehand.

SLIPS.—Wooden slips and paper-covered slips are now very rarely used, 3 inch x 1 inch glass slips being now almost universal. These can be obtained from any optician. They should, preferably, have ground edges, and for general purposes should be of medium thickness. They will cost from twopence to fivepence per dozen, according to quality, or less for a larger quantity. If any of them should be found to have scratches or specks in the centre, they should be put aside for making opaque mounts. For exceptionally large mounts slips 3 inches x 1½ inch can be obtained. The cover-glasses should be circular, in thickness from .006 inch to .008 inch, and might vary in size from ½ inch to ½ inch diameter. It would be well to provide oneself with a stock of ½ inch, ¾ inch, and 1 inch cover-glasses, and to note their thickness at the time of purchase, and, generally speaking, to adhere afterwards to the same standard for ordinary work. High-power work with objectives of very short focus may require thinner cover-glasses to be used. We would also recommend the purchase of a dozen or so slips with excavated cells of various sizes, i. e. with concavities ground in their centers.

Before use, all slips and covers must be scrupulously cleaned. It is generally sufficient to wash them with hot water and soap or soda; but for special work more drastic measures may be necessary. The writer generally uses a fairly strong and hot solution of Hudson's Soap, with subsequent careful rinsing and polishing with an old cambric handkerchief. The great thing to be avoided is any suspicion of grease, even from the fingers themselves. Cover-glasses must be finally polished with chamois leather, and as they are very thin and of course easily broken, various contrivances such as buff blocks are obtainable for

the purpose. With a little practice, however, it is quite easy to hold half the cover-glass in a piece of chamois leather between the finger and thumb, but not edgeways, and to polish the other half, turning the glass round meanwhile.

DRY MOUNTING.—The mounting of opaque objects and of objects that can be mounted dry, is comparatively simple. The various apparatus, reagents, media, stains, etc., will be mentioned as we proceed, and their uses will then become apparent at the same time. Accordingly we shall here require a turntable. This is a circular brass plate about $3\frac{1}{2}$ inches in diameter, mounted so as to rotate upon a centre, the upper surface of this plate having concentric rings engraved upon its surface. These latter serve as a guide in centering the slide upon the rotating plate. There is also a pair of clips to hold the slide in place. The turntable is mounted on a wooden block or iron stand which serves as a support for the hand. The cost will be about six shillings. We do not recommend the "self-centering" turntables. We shall also need two or more good sable brushes, which are best and cheapest in the long run. These should be about 1-16 inch and 3-32 inch in diameter, costing ninepence or one shilling each. Also a pair of steel or brass forceps, not too narrow, costing one shilling and sixpence, a bottle of gold-size, a bottle of Brunswick Black, and a bottle of gum arabic. All of these are obtainable from the opticians.

The usual plan with opaque objects is to place a slide on the turntable, centre by means of the concentric rings, and then run a disk of Brunswick Black of the requisite size in the centre, rotating the stage meanwhile by means of the forefinger of the left hand and the milled head beneath. As soon as this black disk is dry, a piece of black paper of the same size is cut out and gummed upon it. The black paper should not have a glazed surface. Then upon the disk is built up a cell of the requisite depth

to contain the object. This method of mounting opaque objects upon a black background is not only unnecessary, but often inconvenient, as it renders the use of transmitted light impossible, if it should be wanted ; neither can such slides be examined by means of a Lieberkuhn. We recommend therefore that the black background be omitted, and that instead a similar disk, or two or three disks of various sizes, be put upon thin slips, and one of these can then be placed beneath the slide carrying the object, when it is being examined by reflected light.

CELLS.—The cells are made by running a ring of gold-size of the same diameter as the cover-glass that will be used. This is done by means of the turntable, and is not difficult. It is not advisable to use too full a brush, and the gold-size should be of the right consistency—neither too thick to leave the brush, nor so thin as to run away from position. The tip of the brush is used, and the table rotated not to quickly. For very thin objects one ring will suffice ; but thicker objects will need two or three rings, added one on the top of another, each ring being added, however, only when the other is dry. If a few such rings do not give sufficient depth, it is advisable to build up the cell by other means. Rings may be cut out of stout paper or thin and good cardboard, then steeped in parafine and dried. Stout rings of ebonite, glass, tin, etc., can be obtained from the opticians. It is only necessary to attach these to the slide by means of a ring of gold-size, pressing down the ring firmly, and even giving a very slight twisting motion to make sure of there being no air-bubbles to prevent perfect contact. If the cells of gold-size when dry should not be quite level, they can easily be rubbed down on a piece of very fine emery laid on a flat surface. The object itself must be fastened in place by means of a drop of gum placed upon the slide. Care must be taken that this drop of gum is hidden by the object, unless that is impossible. Thin objects, such as

wings, petals, leaves, etc., may generally be kept in place merely by the pressure of the cover-glass. Very minute objects, such as pollen grains for instance, are made to adhere by means of a thin film of very weak gum, which is placed on the slide and allowed to dry. Breathing upon the slide will then moisten the film of gum sufficiently to cause the pollen to adhere when placed thereon. In every case, however, it is of the utmost importance that the gum and gold-size should be allowed to dry thoroughly before the cover-glass is put on, or the remaining moisture will settle on the under side of the cover-glass, and utterly spoil the slide. A final ring of gold-size is then run on, and this last should be allowed to dry until it is just sticky only, when the cover-glass may be gently lowered into place by means of a pair of forceps, and the edges pressed gently down, care being taken that the cover-glass adheres all round its edges. Finally, the slide is finished by a coat of Brunswick Black over all, and just covering the edge of the cover-glass.

THE RICHMOND PARK PONDS.—I am glad to see attention drawn to these ponds and pools, as, personally, I have found them especially productive in one branch of Pond Life, Freshwater Algae. To mention the algae to be found here, would be to enumerate the chief forms of these plants. They occur in the Pen ponds and smaller ponds and pools. As regards other forms of Pond Life, I have met with *Hydra* of a dull brown color, and also of a rich orange-buff. That particular condition of *Euglena*, during which the individuals are aggregated together and are invested with cellulose cell-walls through which they break away, sometimes forms a thick grey-green scum on the surface of the Pen ponds. From what I have seen when collecting Algae, it would appear that the ponds and pools of Richmond Park would well repay systematic investigation in all branches of Pond Life. In conclusion, it will be of interest to mention, that in the neighborhood

occur two such interesting Algae as *Batrachospermum* and *Chantransia*.—*C. E. Britton, 35 Dugdale Street, Camberwell, S. E.*

MANCHESTER MICROSCOPICAL SOCIETY.—We have received from the Manchester Microscopical Society their annual Report and transactions for the year 1898. The transactions themselves are interesting reading, even to non-members of the Society, and most of the papers are well illustrated with excellent plates. We may mention specifically papers by Mr. A. T. Gillanders on "Scale Insects," by Mr. W. H. Pepworth on "Myxomycetes," by Mr. W. Moss on "The Genitalia of the British Hyalinia," by Mr. Chas. Bailey on "Maize," by Mr. Frank Pauden on "Peripatus leuckarti," an Australasian form, and by Mr. Wm. Blackburn on "Myriothela phrygia." The annual address by the President, Prof. Weiss, of Owen's College, is also printed in full, the subject being "Life." Besides the usual field-work the Society has a sub-section for practical work in mounting and technique. It possesses a library, instruments, and a cabinet of micro and lantern slides. The Society has recently extended its usefulness by organizing lectures with demonstrations for the benefit of outside societies and institutions. Eighteen such lectures have been given in the Manchester district during the past twelve past months and we are not surprised to learn that the scheme has been eminently successful. The report and transactions can be obtained from the Hon. Secretary, Mr. E. C. Stump, 16, Herbert Street, Moss Side, Manchester, post free for one shilling and eight-pence. We commend it to the notice of other societies engaged in similar work.—*Sci.-Gossip.*

SPIDERS WANTED.—Any kinds, in alcohol, also centipedes and millipedes, for which good value in micro slides or natural history books will be given by Frank P. Smith, 156 Soundesley Pl. Islington, London, England.

MICROSCOPICAL NOTES.

THE GREAT SALT LAKE.—This is the title of a book just issued from the Deseret News office, Salt Lake City, by Dr. J. E. Talmage, Professor of Geology in the University of Utah. The great interest and value of the book will appear from the chapter on life in the lake reproduced by us on pages 217-224. Other chapters relate to the geological history of the basin, the great economic importance of the salt, the different pleasure resorts, the history of man's contact with the region, and many other points. The 116 pages of text are illustrated by 22 beautifully prepared half-tones and provided with flexible cover. We are not advised of the price but think our readers will be safe in enclosing fifty to seventy-five cents for a copy, either to Dr. Talmage or to the Deseret News.

Wanted.—Earth containing diatoms from Redondo Beach for a European subscriber who offers cash, or, in exchange, Hungarian diatomaceous material from St. Peter. C. W. S.

Microscopic Inspection of Pork.—In 1881, the importation of American pork into Germany, France, and the principal countries of the continent of Europe was prohibited on the assumption that it was infested with *trichinæ*, and was therefore injurious to health. Although it could not be shown that American pork had caused disease it being manifestly more wholesome than European pork, and notwithstanding the most vigorous protests by this Government, the trade was crushed and destroyed. The year before the prohibition went into effect the United States sold to France 70,000,000 pounds of pork, and to Germany, 45,000,000 pounds. For ten years thereafter American pork was shut out of nearly every market of continental Europe, and the prohibition was not raised until the Bureau of Animal Industry began the microscopic inspection and certification of pork destined for those markets. The trade had to be built up anew over the prejudices that had been so firmly rooted, and it has been a slow and difficult process.

Vexatious and burdensome restrictions have constantly to be met, but the trade has continued to grow notwithstanding. During the fiscal year 1892 there were 38,152,874 pounds inspected for export, 22,025,698 pounds going to countries requiring inspection and 16,127,176 to countries not requiring it, while in 1899 the total shipment was 108,928,195, of which 108,858,149 went countries requiring inspection and 70,046 to countries not requiring it.

The regulations for this work provide that a microscopic examination be made of all hog products which are for export to countries requiring such examination. The following from the regulations shows the method of operation:

When the slaughtered hog is passed into the cooling room of said establishment, the inspector in charge, or his assistants, will take from each carcass three samples of muscle—one from the "pillar of the diaphragm," one from the psoas muscle, and the other from the inner aspect of the shoulder, and also from the base of the tongue when that organ is retained for exportation; and said samples will be placed in small tin boxes, and a numbered tag will be placed upon the carcass from which said samples have been taken, and a duplicate of said tag will be placed in the box with said samples. The small boxes will be placed in a large tin box provided with a lock. The boxes containing the samples from the hogs in the cooling room so tagged will be taken to the microscopist for such establishment, who shall thereupon cause a microscopic examination of the contents of each box containing samples to be made, and shall furnish a written report to the inspector, giving the result of said microscopic examination, together with the numbers of all carcasses affected with trichinæ. The samples of pork microscopically examined shall be classified as follows:

Class A.—Samples in which there are no signs of trichinæ, living or dead, calcified cysts, or other bodies or substances having any resemblance to trichinæ or trichinæ cysts.

Class B.—Samples in which they are disintegrated trichinæ cysts, calcified trichinæ cysts or bodies having any resemblance thereto.

Class C.—Samples in which there are living or dead trichinæ bodies not disintegrated.

All carcasses coming within Class C are removed from the cooling room and disposed of by tanking, or they may be rendered into edible lard at a temperature of 150 deg. F., or made into cooked meat products if the temperature is raised to the boiling point a sufficient time to cook thoroughly the interior of the pieces. Carcasses belonging to Class B are rejected for shipment to countries requiring inspection and certification. In all this work (the microscopic examination, the cutting up of carcasses, the marking of parts, and the keeping of records) the most careful and painstaking efforts are maintained. The result is that the pork exported to countries which require inspection is not only absolutely free from trichinæ, but has never been affected by these parasites. The amount of affected pork under Class B and Class C is less than 2 per cent of the whole amount examined microscopically. The number of pounds of pork examined microscopically for export to countries requiring the inspection and to countries not requiring it for the fiscal years 1892 to 1899, was in 1892, 38,152,874; in 1893, 20,677,410; in 1894, 35,437,937; in 1895, 45,094,598; in 1896, 22,900,880; in 1897, 43,572,355; in 1898, 120,271,659; in 1899, 108,928,195.

Before this work was undertaken, it was estimated that it would cost from 15 to 50 cents per carcass, but in fact the cost has been only about 6 cents per carcass. The cost per pound of the pork exported was 0.248 cent in 1894, 0.2 cent in 1895, 0.264 cent in 1896, 0.256 cent in 1897, 0.142 cent in 1898, and 0.182 cent in 1899. There were many and strong objections to the work of microscopic inspection when it was begun, but the results have been so gratifying, especially from a commercial point of view, that not only is there little criticism, but the applications for inspection are numerous. While there is room for discussion of the proposition as to whether the packer or the Government should pay the cost of the microscopic inspection, there is no longer any doubt of the wisdom of having the inspection made under the supervision of the Government.—YEARBOOK AG. DEPT.

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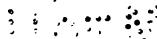
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CONTENTS.

The History and Theory of Staining. Hollborn & Angus.....	241-246
Eucaine Hydrochloride as a Narcotizing Agent. Harris.....	247-249
Photo-micrographic Notes. Norman.....	249-253
NOTES BY SHILLINGTON SCALES.—Objective; Condenser; Catalogues; Formalin; Manchester Society; Swift's microscope; Royal Society; Lemon-tree Scales; Sheep-tick Imago; Aphis with Youug; Ovipositor of Tipula; Humble Bee Parasite; Disjecta Membra of Weevil; Ovipositor of Wild Bee; Cements; Preservative Media; Balsam Mounting.....	253-263
NOTES BY J. H. COOKE.—Microphotography; Camera; Making Notes; Wood Sections; Diatoms; Pus; Bud Sections; Nature Study; Orthochromatic Photography; Light Filter; Mounting Medium.....	264-269

The History and Theory of Staining.

DR. K. HOLLBORN AND HERBERT F. ANGUS.

Of how many sciences can it be said that the seed was sown a full century before the young shoot, destined to become a great tree, showed itself above ground? Certainly it is true of a very great number, and the science of demonstrating histological, and cytological details by means of stains is one of them.

To Prof. Reichert, of Leipzig, is due the credit of having sown the seed, others came after, who, by grafting, so altered the fruit of the tree that the learned professor would now, perhaps, hardly recognize it as of his planting, but he it was, who, in the year 1758, used a decoction of Pernambuco wood for studying the histology of

plants. Thus was the seed sown, but it was nearly a century before any further advance was made, until in the year 1849 the botanists, Messrs. Goppert and Cohn, used carmine solution to study the rotation of the cell contents of *Nitella flexilis*; five years later Hartig made exhaustive experiments as to the possibility of fixing the carmine in relation to the capacity of the different elements of the plant cell; that is to say, of stopping the staining process when, owing to their varying affinity for carmine, the elements were each stained to a different degree, and thus differentiated; he was so far satisfied with his results as to prophecy a great future for the new process.

Already, the knowledge of these experiments had spread widely, and two years later, A.D. 1856, we find Lord Sydney Godolphin Osborne, who was deeply interested in botany, growing plants in carmine solution, and in the next year the chemist, Maschke, of Breslau, endeavoured to further his botanical researches with the same stain. So far all the recorded experiments had dealt only with plant histology, and it was reserved for Gerlach, anatominist, of Erlangen, to first describe the results obtained by the new method in the field of human morphology; he it was who urged on the histologists of his day the necessity of further experiment, both with this and with other stains; and, if to Prof. Reichert is due the credit of planting the seed, to Gerlach is certainly due the credit of so grafting the resulting shoot as to give it its present-day character.

In answer to his appeal there arose a school of histologists devoted to mastering the technique of staining, and in 1871 Weigert succeeded in staining the Cocco-zooglœa, as well as the nucleus of the cell, by means of an ammoniated solution of carmine followed by treatment with muriatic acid-glycerin; in the following year Messrs. Eberth and Wagner succeeded in staining Coccoi, but not Bacilli, with Hæmatoxylin, and subsequently Weigert discovered

that Coccii, especially in *Zooglœa*, could be obtained by various nuclear stains, for this purpose, and for the first time he used an anilin dye, viz., Methyl Violet.

These anilin dyes, destined, in a great measure, to displace carmine and haematoxylin, were first put on the market in 1856, and although recommended by Waldeyer in 1863, were still very little used. Fischer, however, in 1875 introduced Eosin, much used at present as an ingredient in multiple stains, and also for blood work; and about the same time, Ehrlich threw the weight of his authority into the scale; in 1878 we find Weigert recommending the use of Bismarck Brown, and in the next year Ehrlich published his far-reaching classification of the coal tar colors, dividing them into three groups, the Basic, the Acid, and the Neutral; the first class being, in general, sharp nuclear stains, the second, plasma stains, that is to say, stains with a special affinity for cytoplasm, and intercellular substances; and the last, stains with special affinity for certain cell contents; this classification, with one or two reservations, is accepted as correct at the present day.

In the year 1871 Ehrlich conclusively demonstrated that only the basic colors were suitable for bacteriological investigation: Bismarck Brown, Fuchsin, Methyl, and Gentian Violet, etc., but especially Methylene Blue.

The tide had now turned completely in favor of the anilins, and the next few years are particularly rich in the application of these dyes to the various branches of microscopic research.

Weigert applied Acid Fuchsin to the study of the nervous system; Strasburger used Methyl Green, combined with acetic acid, to demonstrate the mitotic figures of cell division; and in the same year, 1882, Koch demonstrated the *Bacillus tuberculosis* by staining first with alkaline Methylene Blue, and subsequently with Vesuvian, whereby the Bacilli were stained blue, the remainder, including other micro-organisms, brown. This method was modifi-

ed by Ehrlich, who, instead of an alkaline solution of the primary stain, used one of the basic dyes, Gentian Violet, or Fuchsin, in a solution of anilin. Ziehl Neelsen still further modified the process by using a carbolized solution of basic Fuchsin, and, it is this last method which is in general use to-day. It will be noticed that the dyes, in that they all belong to the basic group, are the same, the only difference being in the vehicle in which they are dissolved; the importance attached to the choice of the vehicle will best be appreciated by reference to the process of ordinary industrial dyeing, in which a great number of colors directly stain the material immersed, while others require the presence of some substance, generally a metallic salt, or hydrate, technically known as a mordant, before they can be made to give a satisfactory result; the same holds good in microscopic staining, and the Tubercle bacillus, although stained slowly by an aqueous, or alcoholic solution of one of the basic colors, stains much more rapidly when an alkaline, carbolized, or anilin solution is used; these substances serving as mordants.

These bacilli, being thus difficult to stain, are equally difficult to decolorize, and, while immersion for a short time in acid or alcohol will effectually decolorize the other elements of the preparation, they still retain their color, and remain unaffected, even when the decolorized elements are again stained with some contrast stain, as in Koch's original demonstration, in which the bacilli were stained blue, the epithelial cells, etc., brown.

This discovery, opening up as it did the science of Bacteriology, is one of the greatest triumphs of latter-day staining methods. The country folk in many districts, especially Naples, considered Tuberculosis an infectious disease: already Willemin, of Paris, had proved the same by the vaccination of experimental animals, but efforts hitherto made to demonstrate a disease germ had failed, until Koch succeeded with the above mentioned stain.

Now, scarcely any accurate observations are made, in either Histology or Bacteriology, without the aid of stains; and the literature of the subject has increased so largely that it would be impossible, in the space at our command, to give more than a very general outline of the theory, underlying the hundreds of formulas recommended; perhaps, under the circumstances, it will be best to merely draw together the threads of what has already been said.

The chief reason for staining microscopic objects is to differentiate them, that is, to exhibit one group of cells in a different color or shade from another group (a histological stain); or to demonstrate the nucleus, or granules, of a cell by these same color differences (a cytological stain).

Stains may be divided into two great groups (1) General, and (2) Specific; the latter of which may be again divided into three sub-divisions, after the classification of Ehrlich, already mentioned, and into the details of which we need not now enter. Those comprised in the first group, the general stains, color the whole of the preparation, although all the elements are not equally affected; the specific stains on the other hand, as their name implies, color only certain groups of cells, or elements of cells; but there is scarcely any stain so specific that it does not need careful attention as to strength, time it is allowed to act, etc., and these details necessarily bring us to a consideration of the methods employed.

There are two distinct methods, all the various modifications being grouped under one or the other:—(1) The Progressive (2) The Regressive. The progressive method consists in staining just so long as to bring out the elements required, and stopping its action before the other elements are affected sufficiently to destroy differentiation.

The regressive consists in allowing the whole of the preparation to become stained, and then washing out by means of alcohol or acid the stain from those elements, which give it up most readily; of this method we have

already given an example, when speaking of the discovery of the *Bacillus tuberculosis*; the elements thus freed from stain can be restained with another color, those which have resisted the washing out process being unaffected by this second staining, thus we have what is called a double stain.

These double stains are not confined to just that branch of research from which our example is taken, but are equally applicable to animal and vegetable histology; nor is it always necessary to wash out one stain before applying the next, as some stains have the power, when applied subsequently, of replacing the original stain in those elements for which they have a special affinity; others, again, may be mixed in one solution, and thus applied simultaneously, each picking out its own especial element; there are also some valuable triple stains belonging to this "one solution" class, by means of which our knowledge of the leucocytes of the blood has been greatly increased.

The last point needing mention, the theory of staining with mordants, we have already explained at some length; we cannot here enter into the question of the preliminary treatment of the object to be examined, which, according to the various reagents used, favorably or unfavorably affects the subsequent staining.

Here then we have the salient points, at least, of that science, without which the microscope, despite the recent improvements in both brass and glass, would still be little more than a scientific plaything, useful, no doubt, for exhibiting the beautiful and the curious, but incapable of supporting by its evidence any of those numerous sciences, which to-day look to it as their main stay.

For our own part, we are convinced, that in every one of these sciences the advance of the future will depend more on the mastery of the technique of staining, than upon any optical improvement of any kind.—*An. of Micr.*

Eucaine Hydrochloride as a Narcotizing Agent.

GEORGE T. HARRIS.

On commencing work upon any group, the question that the naturalist has almost immediately to decide is that of a suitable narcotic, as few groups permit of much work without such an aid ; and, when permanent preparations are desired, narcotization becomes almost indispensable. Some forms contract so slowly that narcotization may to a very large extent be dispensed with, and some energetic killing agent applied at the outset ; but the percentage of forms amenable to this treatment is very small, and the microscopical naturalist may almost take it for granted that any group he may elect to work upon in zoology will require more or less complete narcotizing before he can proceed to kill. It not infrequently happens that even when the quest for a suitable anæsthetic has been successfully accomplished, trouble will be encountered with the killing agent, as the most suitable "fixer" for the forms under observation may precipitate the narcotic, or in its turn be precipitated by the narcotic. Enough has been said to show that the problem of narcotization is one of paramount interest to the specialist.

When cocaine hydrochlorate came into use, it was found to be applicable to so many groups that it practically occupied the place of an universal narcotizer, as many forms, which previous to its introduction had been anæsthetized with difficulty or not at all, were now comparatively easy to prepare. Yet even this failed signally with some groups, among them being many genera of the Protozoa. With Vorticellidae it was practically useless ; for one or two years I labored patiently, trying to obtain perfect mounts with cocaine, but to no purpose. In some species the cocaine acted perfectly as far as the stalk was concerned, and failed dismally where the ciliary wreath was in question, and in other species the converse took place.

So that after wasting a vast amount of time, I came to the conclusion that the Vorticellidæ were an unpreparable lot. Some months ago, however, eucaine hydrochloride was introduced as an anæsthetic locally for minor operations in surgery, principally on the eye, nose and throat. Reading in medical papers some very appreciative notices of its action compared with that of cocaine, I procured some for experiment, and almost the first trials were upon the Vorticellidæ, the idiosyncrasies of which under a narcotizing agent I knew so well. My delight was extreme when I found that the majority of species were infinitely better narcotized with eucaine. Passing on to other genera of Protozoa I found that, generally speaking eucaine would practically supersede cocaine for work among the Protozoa, and not only cocaine, but camphor mono-bromide, atropine, morphia hydrochlorate, etc. As I was desirous of thoroughly appraising the value of eucaine as a general narcotizer, I proceeded to try it on various families. Among the Rotatoria I selected several species that had given me considerable trouble when using cocaine, *Asplanchna priodonta* being one of them; this I found could be rapidly prepared when using eucaine, and far more effectively also. But in order to confirm my own conclusions, I got Mr. C. F. Rousselet to introduce eucaine into his practice, and he reports most favorably on its action in preparing *Flosculariæ* and other somewhat difficult forms. Among the Vermes I selected a specimen of *Nais proboscidea* in an advanced stage of budding, as I had always found that cocaine and other narcotizing agents, when applied to a *Nais* in this condition, irritated it to such an extent that severance always took place at the budding segments. With eucaine, the irritation was so much less that almost satisfactory mounts could be obtained.

With cocaine, a two per cent solution is most generally used, but eucaine seems far more energetic in its action,

and it does not seem desirable to work with stronger solutions than one per cent ; in fact the Chemische Fabrik auf Aktien recommend a ten per cent solution for general surgical purposes. Their directions for preparing such a solution are as follows :—

“To one part of Beta-eucaine add forty-nine parts of distilled water ; heat the mixture in a test tube over a spirit lamp until solution has taken place, then heat to boiling in the test tube, the mouth of which must be plugged with cotton wool.” This, it may be mentioned, is the method whereby a sterile solution is prepared ; for zoological work such precautions are unnecessary, and the one per cent solution may be prepared by simple solution in distilled water.

Solutions of Beta-eucaine are said to be perfectly stable in aqueous media, and it has generally been assumed that aqueous solutions of cocaine are not stable. This assumption has always appeared to me unproven, as I have had solution of cocaine in plain distilled water that have kept without any antiseptic for many months, and that have done their work as perfectly at the end as at the time of their preparation.—*Annual of Microscopy*.

Photo-micrographic Notes.

ALBERT NORMAN.

It seems often to be thought that lime-light is essential to the photo-micrographer, whereas every photo-micrograph can be taken successfully with a simple oil lamp which may have a half-inch wick ; or better still, an inch wick ; or a lamp with a circular wick may be used, and this latter the writer considers cannot be beaten for ease in working and certainty of equal illumination, only the exposure is rather long compared with lime-light. Thus a specimen of bacilli magnified one thousand diameters, which requires an exposure of one minute with a

blow-through jet, would take about three minutes to be sufficiently exposed with a round-wick lamp.

The straight-wick lamps, used edge-on, work quicker, but it is more difficult to get even illumination with them.

In many cases when photographing very delicate or unstained specimens, an oil light is of the greatest service, and will be found to give better results than can be obtained by modifying the brilliancy of the lime-light with several screens.

Lime-light is often used to quicken the exposure, to prevent the blurring of the image due to vibration.

I have come to the conclusion that vibration has been greatly over-estimated, and cannot conscientiously say that any one of my photographs has shown a blur from this cause ; it is more honest to put the want of sharpness down to bad focussing, if care has been taken to render the image as perfect as possible, optically, by focussing the substage condenser, and correct the objective by collar or tube.

Vibration may occur if one is working in a house near a railway, or very near a thoroughfare where the traffic is thick and heavy, but in ordinary circumstances it is the writer's opinion that any floor of a house or building may be used, and that if the apparatus be placed on a firm table, and the legs of the table be supported on layers of felt, no blurring of the image will be found to occur due to vibration ; but, in nine cases out of ten, it will be due to incorrect focussing, or to some carelessness on the part of the operator, such as jerking the apparatus when pulling out the dark slide.

A good way to insulate the legs of the table is to have blocks of wood about four inches high each with a hole about three inches deep, and rather larger than the part of the leg nearest the floor.

Cut some circular wads of felt and slip them into the holes, then place these blocks so that the legs of the ta-

ble rest on the felt and do not come into contact with the wood at the side. There is another cause of blurring of the image, namely, a faulty connection between the fine adjustment of the microscope and the long-focussing rod which runs by the side of the camera. Rubber bands of any description are not a success.

In last year's Annual is a short description of the mechanical contrivance made by the writer, which is being used daily. It responds readily to the touch on the focussing rod, and, when a sharp image is obtained, keeps perfectly steady.

A shifting focus, due to the expansion and contraction of the apparatus from varying degrees of temperature, has never given me any trouble, although all work is done in the winter about six feet from the fireplace with a good fire burning, the camera and microscope being set up each time and work begun without waiting for the parts to become uniformly warm.

Lime-light is exceedingly useful for high-power work, such as the photography of bacteria at one to four thousand diameters, but at one thousand diameters it is not essential, for an oil lamp with an inch wick used edge-on will fully expose a medium orthochromatic plate in from one to two minutes, using a 1-12th apochromatic objective, and Zeiss' No. 4 projection ocular.

The writer always uses a blow-through jet and Zirconium lime for the higher magnifications up to four thousand diameters. Photography at this power is not often necessary or useful, and when the occasion arises one can easily sit down and wait during the ten or fifteen minutes which are required for exposing the sensitive plate. It seems to me that better results are obtained by using a medium power illuminant and giving a little longer exposure, than by using the brightest possible light with quick exposures.

For fine low-power work the blow-through jet is often



too powerful, but now comes in that useful adjunct to our kit—an oil lamp with a circular wick, which to me is indispensable. Of course, one could use screens and ground glass to cut off the excess of light given off from the lime, besides stopping down the iris diaphragm at the back of the substage condenser, but the image will not equal in purity the one illuminated by the weaker oil lamp. And then with the help of a bull's-eye there is the perfect certainty of getting an even ground if the slightest care be taken. I would advise intending photo-micrographers to study first of all the art of photography, to buy a quarter or half-plate camera, and learn how to focus so as to get sharp pictures, and how to get the best work out of the lens they are using. Consider carefully what exposure is necessary, for the power of judging can be obtained by practice, and will be of the greatest service when the more difficult microscopic branch is begun.

When one can take six plates into the field, and return home and develop them into six good negatives, it is more than likely that the troubles of photo-micrography will not weigh so heavily as to make the struggler throw the whole thing up in disgust.

The simplest way of starting is to place the microscope tube, without an eyepiece, into the lens aperture of a half-plate camera, making a light-tight joint with cardboard and velvet, and getting illumination either by the use of the mirror and daylight, or by using transmitted light from an oil lamp and bull's eye.

Much can be done in this way for practice, taking as the object the foot of a fly or spider, and using an inch objective and a single substage condenser.

After getting some successful photo-micrographs and feeling certain that the interest aroused is not transient, buy a proper apparatus with the best objectives you can afford. Messrs. Watson & Son, High Holborn, make two or three kinds of photo-micrographic cameras which can

be strongly recommended. Then set to work, making up your mind to overcome the many difficulties which are sure to occur before proficiency is reached.—*Annual of Microscopy*.

Notes on Microscopy.

F. SHILLINGTON SCALES, F.R.M.S.

NEW 1-12IN. IMMERSION OBJECTIVE.—Messrs. R. and J. Beck have sent for our inspection a new 1-12 in. immersion objective with a numerical aperture of 1.4 and an aplanatic cone of 1.35 N.A. It is perfectly achromatic, and the makers modestly and rightly claim no more than this, but we can speak highly of the performance of the lens. It is exceptionally free from color, the definition is excellent, and the increased quantity of light passed is most noticeable. It bears comparatively high eye-pieceing well. The working distance is of course rather less than in objectives of lower aperture. The price brings it within the reach of all workers requiring an objective of this description, being \$40, or \$48 with correction collar.

NEW IMMERSION CONDENSER.—Competition between the opticians grows apace and the worker and the amateur benefit accordingly. Messrs. Beck have brought out a new immersion condenser, which we commend herewith, with a numerical aperture of 1.36 to 1.4, and an aplanatic cone of 1.3 N.A. The combination consists of four systems of lenses, the front of which is a hemisphere with three combinations behind, and constructed on the principle of an oil-immersion objective. By the courtesy of the makers we have had an opportunity of testing this condenser in connection with the objective 1.4 N.A. above described and are much pleased with its performance. The working distance is 0.6 in. By an ingenious arrangement the optical part of the condenser can be reversed in the mount so that it may be used with microscopes fitted with under-stage fitments instead of the

usual focussing substage. The top lens is also removable. The price of the optical part is only \$13; of the mount, with iris diaphragm and carrier for stop, \$5; the stops and colored glasses in brass box, \$3. Total, \$21.

NEW CATALOGUES.—We have received catalogues of microscopes and apparatus from Mr. J. H. Steward, of 406 and 407 Strand and 7 Gracechurch Street, and from Messrs. A. Clarkson & Co., of Holborn Circus. The former contains several microscopes of excellent design, and a full list of accessories, but is cumbered, as is too often the case, with types of microscopes of antiquated patterns long since superseded, which, we think, would be better deleted, as they do not enhance the reputation of the maker, and are likely to mislead beginners. Messrs. Clarkson's catalogue is almost entirely devoted to second-hand instruments, all offered at moderate prices, and nearly all are of good and recent models.

FORMALIN AS A PRESERVATIVE.—A 3 per cent solution of formalin is preferable to spirits of wine for preserving certain species of insects, as it does not affect the colors. I find, however, that specimens so preserved and afterwards dried deposit an oily dew, or in some cases crystals, on the slide and cover-glass if mounted as dry objects for the microscope. Washing appears to have little or no effect. Can anyone tell me how to obviate this without discoloring the species?—*E. G. Wheler, Swansfield House, Alnwick.*

MANCHESTER MICROSCOPICAL SOCIETY.—The transactions for 1899 show that it is the most enterprising and successful of any microscopical society in the provinces, and well deserves its success. The membership during the year appears to have been well maintained. The Council speak of the attendance and the interest in the meetings as being in every sense satisfactory. The Extension Section appears to have delivered thirty-seven lectures in the neighbourhood of Manchester during the winter: by

so doing they have benefited many outside their own membership, and doubtless added to the popularity as much as to the usefulness of the Society. The well-known Yorkshire Naturalists' Union, has, we believe, a similar scheme in hand. The President of the Manchester Society for the year is Professor Sydney J. Hickson, D.Sc., of Owens College, and his presidential address on zoophytes is the first paper in the report. Perhaps the most important paper is one by Mr. F. W. Gamble, of Owens College, on "The Power of Color-change in Animals," a subject in which the author is specially interested, and concerning which he and Mr. F. W. Keeble have been able to make original investigations. The most interesting papers to our readers will be one on "Collecting Lepidoptera," by Mr. H. G. Willis, from which we would have liked to make extracts had space permitted, and another on "Arboreal Aphides," by Mr. A. T. Gillanders. Amongst other papers we may particularize one on "Termites and Ants of West Africa," by Mr. Mark L. Sykes, and another on "The Pollination of Flowers," by Mr. Charles Turner. There are several excellent plates. Mr. C. F. Rousset's "Method of Preserving and Mounting Rotifera" is given in full; and as this method has been brought prominently before microscopists, we shall reprint it in our next issue. The Report can be obtained, from the Hon. Secretary, Mr. E. C. Stump, 16 Herbert Street, Moss Side, Manchester. A list of the Extension Section's lectures can be obtained from Mr. George Wilks, 56 Brookland Street, Eccles New Road, Manchester.

SWIFT'S NEW PORTABLE MICROSCOPE.—Messrs. James Swift & Son have recently brought out a new folding microscope for travelling, for bedside diagnosis, or for field work. It is furnished with both coarse and fine adjustments, the latter being markedly superior to those usually fitted to microscopes of this type. The optical tube carrying the objectives is made to slide in its fitting so as

to allow very low power objectives to be used. There is a drawtube permitting a total extension of tube-length to 7 inches. The stage is larger than usual, and carries a sub-stage ring fitted with Abbe condenser and iris diaphragm. The back leg is divided so as to pass over the fine adjustment screw when folded, whilst the stage is hinged and lies flat against the body of the microscope. The microscope packs thus into a leather case about 9 x 3 x 3 inches, and there is room for two objectives, live-box, small bottle, and also sundry minor apparatus. The whole microscope is beautifully finished in bright brass, and is, we think, one of the best of traveling microscopes in the market. The price of the stand, with one eye-piece and the necessary case, but without objectives or other apparatus, is \$24.50.

ROYAL MICROSCOPICAL SOCIETY.—At the meeting on June 20th, the President, Mr. Carruthers, F.R.S., in the chair, Mr. C. H. J. Rogers exhibited a modification of the Rousselet compressor, in which two thin india-rubber bands, sunk into grooves, were employed to keep the cover-glass in position. The advantage of this modification is the facility with which a broken cover-glass can be replaced. Mr. Chas. Baker exhibited an acromatic substage condenser which was a modification of Zeiss's model of the Abbe condenser, the N.A. being 1.0, aplanatic cone 90°, lenses 7-10 inch diameter, working distance 4-10 inch. With the front lens removed the condenser is suitable for use with low-power objectives. A short paper by Mr. E. B. Stringer on a new projection eyepiece and an improved polarizing eyepiece was taken as read. Miss Loraine Smith contributed a paper on some new microscopic fungi, and Mr. Bennett in commenting thereon referred to the proposed cultivation of fungus parasites on certain insects, especially on the Continent and in Australia and America, with a view to getting rid of insect pests, locusts, and others. The President then read a paper, and

gave a lantern demonstration on the structure of some palæozoic plants.

SCALE FROM LEAF OF LEMON-TREE.—The scale insects, *Coccidæ*, members of the order *Hemiptera*, sub-order *Homoptera*, belong to that division of the sub-order which is distinguished by having only one joint on the tarsus. The females are common on many plants, and are found both on leaves and bark. They appear as small, brown, waxy, convex lumps, more or less elliptical according to species. If the brown case be lifted, one sees a small fleshy mass, with eggs, and usually a cottony substance. The fleshy mass is the female, which dies as soon as the eggs are laid. The eggs hatch into a small, active larval insect with eyes, legs, antennæ, and a sucking mouth. After a time these insects fix themselves to a leaf or the bark by means of their sucker. If they are to become females they excrete the waxy shell, throw off all legs and processes, lay their eggs, and die. If they are to develope into males they draw in their legs and become chrysalids, with a process on each side containing the future wings. The adult males are seldom seen. The male and larva are figured in Miss Ormerod's book. A friend of mine is now trying by an ingenious contrivance to obtain specimens of the males and larvæ. He has run the branch of a rose tree, not cut off, into a lamp chimney, and packed the ends with cotton wool. He thinks that when the scale eggs on the branch hatch out he will find the larvæ inside the glass. The second slide shows a scale in which a parasite, probably an ichneumon fly, has laid its eggs, and the grub has hatched and eaten all the scale eggs. The grub is shown lying by the side of the scale. The scales thus attacked are usually of a lighter color than the rest.

SHEEP-TICK IMAGO.—A tick is a degenerate fly that has lost its wings. The sheep-tick passes the larval state inside the body of the mother. The pupæ may be found in little brown shiny cases about three millimetres in diam-

eter. If these are broken open the fully formed tick is seen inside. These are better adapted for mounting than the adult insect which has already sucked blood. The spiracles should be noticed, especially the thoracic ones; also the toothed claws and the tree-like formation between them, answering to the pad on the foot of the house-fly.

APHIS WITH YOUNG.—The peculiarity in this case is that the winged female in November ought by all rules to be oviparous. The fact of this one being viviparous at that time of year shows how circumstances modify natural habits. The chrysanthemum from which this aphis was taken was in a greenhouse; had it been in the open air the aphis would have laid eggs—at least, if entomologists are to be believed. In the slide showing the pupal aphis the wings are still seen confined in their cases. Both larval and pupal aphides produce young: a phenomenon known as Poedogenesis. Aphides during the summer are viviparous and produce their young parthenogenetically. In the autumn the union of the sexes takes place and the result is, not living young, but eggs. The species of aphides are very numerous. The aphis which spins the wool on apple trees has no cornicles. Aphides, like Coccidæ, are of the order Hemiptera, and sub-order Homoptera, but belong to that division of the sub-order which has two joints on the tarsus (Dimeræ).

OVIPOSITOR OF TIPULA.—This is a curious organ of the "Daddy-long-legs," but the parts are not arranged on the slide as in nature. There are 250 species of *Tipula* known. They lay their eggs in the ground or on the surface in batches of 200 or more. The eggs are black. The grub produced from the egg is known as the "leather jacket," and is very destructive. This last remark applies to only two of the 250 species. I should very much like to know what those battledore-like objects lying near may be.

OVIPOSITOR OF TIPULA.—Had there been only two of

those battledore forms one might have suggested that they were the "halters" or abortive wings of the *Tipula*, but as there are three, that suggestion will not do. The viscera attached show that they are connected with some of the internal arrangements.—*Rev. Adam Clarke Smith.*

PARASITE FROM HUMBLE BEE.—These are mites and near akin to spiders. They have eight legs and are therefore not insects. The crab-like toothed jaws are curious. I do not know the name of this mite, but it cannot be mistaken for *Stylops spencii*, parasitic on bees and other Hymenoptera, which used to have an order all to itself (*Strepsiptera*), but which is now included amongst Coleoptera.

This belongs, no doubt, to the family *Gamasinae*. I have a number of species of this family in my possession, but not this particular one. Several species are found parasitic on beetles and bees. I think, on referring to a written description I have by me, that it is *Gamasus coleoptratorum*, Linn., and if so, to bear its name, it ought to have been found on a beetle instead of a bee. Shuckard does not mention it in his "British Bees." I have measured the body of one of these on this slide, and it is 1-25 of an inch long; but in my description of *G. coleoptratorum* it should be only 1-50, so the correct name is doubtful.—*Charles D. Soar.*

In *Knowledge*, of November, 1894, there was a good account of the Crane Fly, or Daddy-long-legs, by Mr. Butler. He says: "The hinder part of the body of the female tapers regularly to a hard and sharp point. This acute tip is the hardest part of the body, and necessarily so, as it has to do the hardest work. It constitutes an egg-laying instrument of superior quality, and is composed of four pieces disposed in pairs. On the upper side are two long and pointed pieces which form the sharp tip, and are used as borers, and underneath these is the other pair, considerably shorter and blunter, their function being to

guide the eggs in their passage into the hole prepared for them by the pair of borers." The whole apparatus, therefore, is something like a combination of an auger and a spoon. The study will make this clear. When egg-laying the creature balances itself on its two hind legs and ovipositor, whilst the fore front legs are up in the air. I have also slides of Sheep-tick and ovipositor of Wild Bee. Is this the ovipositor? It is a strange one.—*T. G. Jefferys.*

DISJECTA MEMBRA OF COMMON WEEVIL.—It is no use mounting this very hard and opaque beetle whole, as one cannot see anything in that way. The weevils are an order of Coleoptera, the common weevil being an example, and are furnished with long snouts. Hence they are also called Rhyncophora=snout bearers. The really distinguishing mark of the order is the elbowed antenna. These common weevils are found in immense numbers in the wheat imported from Calcutta and from Australia, and infest granaries and mills. They bore a hole in the wheat grain with their long snouts, which are furnished with a row of teeth at the tip, by a sort of turning movement, and in this hole the egg is laid. The hole is then plugged with gum secreted by the female, and the grain looks none the worse. The egg hatches in a few days. The change from larva to pupa, and from pupa to imago, takes place within the grain. The imago eats its way out. They are said to breed only when the temperature is above 65° F. It is a remarkable thing that they never injure the germ of the grain, which therefore grows as well when it has served as a nest and home for this little pest as previously. The eyes at the base of the snout should be noticed, and also the gizzard.

OVIPOSITOR OF WILD BEE.—I do not know the name of this bee. There are, I believe, over 200 species of wild bees in England. This is large, long, and black, one that I have never seen except in the autumn, and which seems

especially to frequent the common red fuchsia. The organ is undeniably curious, but lacks the finish generally sound in nature.—*Rev. R. S. Pattrick.*

CEMENTS.—Instead of gold-size other cements may be used ; but we have found gold-size, especially if old, most satisfactory, save for certain fluid mounts. Bell's Cement is excellent, and so is Ward's Brown Cement, whilst Mr. Cole recommends Watson's Special Club Black Enamel. Marine Glue is to us an abomination, and we have long discontinued its use. Under any circumstances it must be applied hot.

MOUNTING IN PRESERVATIVE MEDIA.—There are many more or less specialized methods of this, but it will be sufficient if we confine ourselves to two—namely, Canada balsam and glycerine jelly. These two methods, and especially the first, are used universally. Objects or sections may need careful preparation beforehand, but we will deal with these methods afterwards, assuming here that, as frequently happens, no such preparation is necessary. Canada balsam is best purchased ready for use, in which case it will be obtained as a solution in benzole or xylol. It should be kept in a wide-mouthed bottle, provided with a glass rod for dropping the contents upon the slide, and with a closely-fitting cap instead of stopper. The bottle must be kept closed as much as possible. Glycerine jelly is practically a mixture of glycerine and gelatine which liquefies when warmed. It can be obtained in 25 cent bottles fitted with an ordinary cork. The first important distinction to be noticed between them is that whilst objects mounted in Canada balsam must be freed from every trace of water, those mounted in Glycerine jelly must be first soaked in water or some aqueous medium.

In both cases a mounting-table and lamp should be provided. The table in its simplest form is a plate of brass about 4 x 3 inches, standing on four legs about 3 or 4 in-

ches high, and will cost about 75 cts. The lamp is a small glass methylated spirit lamp, with a glass top, such as is used in laboratories to go beneath the table. This can be purchased for 25 cents.

BALSAM.—The actual process of mounting in Canada balsam may be carried out as follows. We will assume that the object has received a final soaking in turpentine. Having carefully cleaned both slip and cover-glass, the latter is taken up in a pair of forceps, and, the slide having been breathed upon to slightly moisten it, the cover-glass is placed on the slide and pressed there to make it stay in position. The slide is then placed on the table and the lamp lighted and put beneath. In less than half a minute the plate will be sufficiently warm—the heat should be no greater than will allow of the finger being placed on the end of the slide. A drop or two of balsam is then placed on the cover-glass which is on the slide, care being taken that it does not overrun the margin of the former. Into this the object is then lowered or slid by means of a section-lifter (a cover-glass held in a pair of forceps may serve) and a needle set in a handle. Care should be taken to get the object right down under the balsam and close to the cover-glass. The object should then be examined with a pocket-lens to make sure that its position is satisfactory, and to see that no air bubbles are visible in or around it. It is then placed under a watch-glass or other cover to protect it from dust, and put aside for twelve hours to harden. It will be found that the balsam skins over very rapidly on exposure to the air, and no time, therefore, must be lost. The warming of the slide partly obviates this.

After hardening for twelve hours it is as well to make an examination under the lowest power of the microscope before proceeding further, to make sure that the object itself is properly in position and free from air-bubbles or contained air. The slide is then again placed on the mount-

ing-table, and the insertion of a needle will readily release the cover-glass. Warm as before, apply a fresh drop to the centre of the hardened balsam, lift with a pair of forceps, reverse quickly, and lower gently down upon the slide, pressing down carefully so as to squeeze out the excess of balsam and to carry any air-bubbles with it. The cover should now lie flat on the slide. It is better to have a slight excess of balsam rather than a deficiency. In case of the latter a drop must be put against the cover-glass, when it will quickly run in by capillary attraction. Small bubbles, other than any embedded in the object itself, may be neglected, one of the advantages of Canada balsam being the readiness with which it will absorb these.

There are certain objects, however, which are very difficult to free from larger bubbles than the balsam can absorb. In such cases it is advisable to again heat the mounting-table, whilst holding the cover steadily, but not too heavily, in position by pressing on its centre with the handle of a dissecting-needle, until the balsam is seen to boil. At once remove the lamp, but hold the cover-glass steady until the balsam seems to have set again. By this means, though it needs caution, the bubbles will be driven clear of the cover-glass by the ebullition of the balsam. Wire spring clips can be obtained for a penny each, and it is advisable to slip one of these on before putting the slide on one side to harden. This may take twenty-four hours, or it may take a week, according to the amount of balsam used or exuded. Under any circumstances it is well not to hurry matters. The excess can then be removed with a sharp knife nearly up to the cover-glass, and the remainder cleaned up nicely with a rag dipped in turpentine, methylated spirit, or benzole.—*Sci.-Gossip.*

Wanted.—Microscopic preparations illustrating the histology of petals and sepals. Would like to get a full set for John H. Lowell, Waldoboro, Maine.

Notes on Microscopy.

JOHN. H. COOKE, F. L. S., F. G. S.

MICRO-PHOTOGRAPHY.—This is one of the simplest and best methods known for making permanent records of microscopic studies. It is not, however, so universally used as it should be, and this, not so much for the few difficulties that it offers, as on account of the mistaken ideas as to the cost of the apparatus required. Good work may be done by a patient and skillful manipulator with an ordinary camera, or any other makeshift arrangement; but such good work would, in all probability, be rendered still more valuable by the use of apparatus specially designed for the work. The question of cost can no longer be considered seriously as an obstacle to its practice. There are now several makers who are prepared to sell well-made cameras for photo-micrographic work at prices considerably less than the cost of an ordinary camera. Messrs. Griffiths, Highgate Square, Birmingham, have a particularly good apparatus, consisting of a well-made bellows camera, extending from twelve to thirty inches, and attached to a neat base, carrying camera, microscope, and condensers. The object is readily focussed in any position by means of a long, adjustable brass rod which is attached to, and runs the whole length of the camera, and which is connected with the milled head of the fine adjustment screw of the microscope by means of a silk thread passing over a grooved wheel at the end of the rod. It is made in half-plate size with carriers for smaller-sized plates, and its price places it within the reach of all.

CAMERA.—The photography of living bacteria and other cultures cannot be successfully accomplished with a horizontal camera. The use of an upright apparatus is the best but it is open to many objections, chief among which are its instability, the difficulty of focussing, and the fatigue it occasions the operator. Mr. Brightman, has devised a

useful and substantial support, which overcomes these difficulties, and enables the photographer to successfully operate with his apparatus at an angle of 45° to the vertical. The arrangement is a good one, and is already in use in medical circles.

MAKE NOTES.—One important habit which the microscopist should cultivate is that of making copious notes of observations. He should never be without his memorandum or note book. No more profitless work can be imagined than collecting natural history specimens and material without some specific aim or object. Every observation made should be carefully recorded, and the date of capture, locality, and, where possible, the food-plant, should always be attached to the specimens when these are mounted. For field memoranda the use of a stylographic pen is advisable, as pencil writing is apt to rub and efface in time by the motions of the body. A larger record book for more extended notes should be kept at home for biological details. When studying insects, for instance, notes on adolescent states, which it is intended to rear to the imago, cannot be too carefully made, or in too much detail. The relative size, details of ornamentation and structure, dates of transformation from one state to another—indeed everything that pertains to the biography of the species—should be noted down, for where exact data are so essential, little or nothing should be trusted to mere memory.

Wood SECTIONS.—In photographing wood sections without a lens, Herr Fomm places a piece of tinfoil on one side of the section and the film surface of a piece of bromide paper against the other side. A good impression—showing clearly the rings and rays of the wood—is produced in about a half a minute when a metallic point negatively charged by an influence machine is brought within two inches of the paper. It is explained that the paper becomes negatively charged, and a photographically ac-

tive glow-light is produced between it and the wood. It this proposed to try this mead for copying drawings and for other purposes.

DIATOMS.—In collecting, a spoon attached to a stick may be used for skimming the brown diatomaceous ooze off the surface of the mud; a drag net serves this purpose in the case of forms occurring at greater depths, e. g., *Surirella*. The latter should be placed with water in shallow glass vessels sheltered from direct sunlight. The diatoms will appear in masses on the surface of the mud after twelve hours. Transfer them by means of a pipette to the fixing fluid. Fleming's chromo-aceto-osmic acid, and sublimate, in aqueous or alcoholic solution, is recommended as being the best reagent for demonstrating the delicate structural features of the nucleus and cytoplasm during division. The chromatic elements of the nucleus are well shown by picro-sulphuric acid followed by haematoxylin. The arrangement of the cytoplasm, the chromatophores, and other inclusions in the cell may be well brought out, in unstained preparations, by a one per cent osmic acid solution. A solution of iodic alcohol (45 per cent) is recommended for the study of the so-called "red granules" of Butschli, which, by the foregoing method, stain well after fixing. Large forms receive a somewhat different treatment. They are removed individually with the aid of a capillary tube and a dissecting microscope, and are transferred to the fixing bath. The solution is decanted off after fifteen minutes and the objects are passed through water and alcohol, of strengths increasing to the absolute point. This extracts oil and the coloring matter of the chromatophores. The preparation is then passed through alcohols of decreasing strength into distilled water, after which it is stained in a weak solution of Delafield's haematoxylin. The material is then passed successively through 35, 70, 95 per cent and absolute alcohol into clove oil and finally mounted in dammar.

PUS.—The following simple method for examining the gonococci of purulent ophthalmia is suggested by Dr. W. B. Canfield. A little of the pus is pressed between two cover-glasses, which are then drawn apart. The glasses are allowed to dry, and are quickly passed through a Bunsen flame to coagulate the albumen and to fix the pus. A few drops of the ordinary methylene blue or violet are allowed to cover the specimen for a few minutes and washed off, after which the specimen may be examined in water or glycerine, or it may be dried and mounted in balsam, which makes it more distinct.

BUD SECTIONS.—Sections of buds may be quickly prepared for class demonstration by the following method. Fix the specimen in the section cutter, wet it with alcohol, and slice off the sections, meanwhile keeping the knife flooded with alcohol. Place the specimens in alcohol tinged with iodine green, and leave them there for several hours until the solution becomes colorless. Next place them in a solution of alcohol and eosin, and leave them till they assume a pink color. Pass them through an alcohol bath, immerse in clove oil a few minutes, and mount in balsam.

NATURE STUDY.—The curriculum of elementary schools has recently undergone a much needed and welcome reform. The new code contains, *inter alia*, the official sanction of the Board of Education for the recognition of nature study as a means of educating the children of the people. This is a step in the right direction, for when children are early taught the nature study of every-day life, and become familiar with the common things in nature around them, their ideas as to cause and effect in natural phenomena will cease to be associated with superstition and mystery, and the range of available information open to them will be indefinitely extended. No education that does not include a knowledge of the every-day phenomena of nature can be regarded as complete; and as there is a very wide range of the most essential and practical knowl-

edge that can be reached only through the microscope, the day may perhaps be not so far distant when the microscope, as an aid to nature study, will be used more extensively and more seriously in our public schools than it is at present. There is no reason whatever why a compound microscope of low magnifying power should not be just as much as a common appurtenance of a well-regulated elementary school as a blackboard or a piano.

BOOK.—All who are interested in microscopy and photo-micrography should obtain a copy of an interesting little brochure entitled "Orthochromatic Photography," which is being distributed gratis by Messrs. Cadett and Neall, Ashstead, Surrey.

LIGHT FILTER.—We have recently had an opportunity of experimenting with the "Absolutus" light filter used in conjunction with the Cadett Lightning Spectrum plates. The great rapidity of these plates, the sensitometer number of which was 360, renders them especially suitable for photographing the movements of microscopic plants and animals, while their extreme sensitiveness to all color luminosities of the spectrum, excepting a very small margin at the extreme red end of the spectrum, enable them to represent with great delicacy the gradations in the colored luminosities of stained preparations. The "Absolutus" light filter, which is specially adjusted for the spectrum plate, renders all gradations correctly with but a very small margin of error. It may be used either before or behind the objective. Its use increases the exposure at a window with a northern outlook about twenty times, but this is really no drawback with the Lightning plate, as, owing to its great rapidity, the exposure necessary is invariably shorter than it would be when using an ordinary plate without a filter. The surfaces of the "Absolutus" are optically worked, and the coloring accurately adjusted by the help of Abney's color sensitometer to suit the spectrum plate. Workers with light filters know

the unsatisfactory nature of ordinary colored glasses and fluid cells. The care bestowed on the manufacture of the "Absolutus" eliminates most of the objections, and, in addition, the coloring of the screen is pleasant to the eye, and it does not interfere with the definition of the image.

The acetylene flame may be rendered monochromatic by the interposition of a screen of cobalt blue glass between the light and substage condenser.

The principal uses of a light filter in photomicrography are for the correction of the objective, the increase of contrast in the image, and the increase of resolving power. Dr. S. Czapski has shown that the greatest resolving power is obtained by using light or short wave length, even the ultra-violet. This is due to the fact that the blue end of the spectrum has the shortest wave length, and the limit of resolving power is one-half of the wave-length of the light used.

MOUNTING MEDIUM.—In his presidential address to the Quekett Society, Dr. Tatham drew attention to a mounting medium consisting of piperine and bromide of antimony, with which he has obtained very satisfactory results when examining lined tests. The mixture is prepared by combining three parts by weight of piperine and two of antimony bromide, by gently fusing the mixture over a spirit lamp, care being taken not to raise the temperature more than is necessary or it will char and discolor. After the diatoms have been spread on the cover-glass in the usual way, a small portion of the mixture is placed between the cover-glass and the slide, and gently fused until a thin film of it unites the two surfaces. When the medium is set it must at once be protected from the air, otherwise the salts will decompose. To effect this, solid paraffin should be allowed to run between the cover-glass and the slide, and the whole finished off with a circle of Hollis's liquid glue.—*Knowledge*.

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CONTENTS.

Hyalodiscus in the Neocene Deposit. Edwards	271-275
Amœba Having No Vitality. Edwards	275-279
•A New Exhibition Microscope.....	279-280
On the Metallography of Iron and Steel Merritt	280-287
Malaria and Mosquitos. Ross	287-290
The London Microscope. Beck	290-292
A New Method of Counting White Blood Corpuscles. Kourloff	292-293
Universal Sizes. R. M. S.	294-295
NOTES BY J. H. COOKE.—Blood; Warm Slides; Water Baths....	295-297
NOTES BY SHILLINGTON SCALES.—Material for Botanical Study; Mounting	297-298

Hyalodiscus in the Neocene Deposit.

ARTHUR M. EDWARDS, M. D.

For many years I have suspected that that beautiful Bacillarian Hyalodiscus subtilis which J. W. Bailey described and named could be found if looked for in the fossil state. Bailey found it, it will be remembered, on *algæ* growing at Halifax, Nova Scotia. I have now found it in that problematical rock, the Neocene of California. This is called the Miocene Tertiary by the older geologists. Therefore, I wish to clear up the synonymy of that form and, at the same time, to furnish what I know of its habits. Just after Bailey died, he left his collection to the care of the Boston Society. This society gave me the leave to examine it and when in Boston I did so. Before

then, Charles Stodder, residing in Boston, sent me to examine certain slides of *Bacillaria* from the Bailey cabinet. Among them was one from *Halifax*, *Nova Scotia*, containing *Hyalodiscus subtilis*, the type slide from which had been described the form in question. Then I had in my possession the original from which J. E. Gavit had engraved the celebrated picture, which Mr. Gavit told me was an etching on steel, in the Smithsonian contributions to Science. It showed at that time just the same as the picture exhibits it. For remember, then one had not immersion lenses to work with, and the making of lenses, if we except those of Charles Spencer and some of Tolles, was crude and I may say imperfect. The markings were resolved with difficulty into two fine lines looking, as Bailey said, like the engine turning on the back of a watch, no more. The centre was always occupied by a rough part, and that was indefinite in outline, with no seeming markings, as they are called, arranged symmetrically. Thereafter I had slides labelled *Hyalodiscus subtilis* from various sources, but *Halifax* was supposed to be the true locality.

In January of 1877, I went to California, partially to study the *Bacillaria* of the Pacific coast, and I had *Hyalodiscus subtilis* or *californicus* growing in San Francisco harbor where I resided along with *Arachnoidiscus ehrenbergii*. I collected it and had a chance to study it pretty thoroughly. I had it from all along the coast of California. I had it also from the state of Washington, where it is common. I also collected it at Saucellito, just opposite San Francisco on the northern side of the Golden Gate, a form which proved to be *Hyalodiscus cervinus* of T. Brightwell and thought it was different from *Hyalodiscus subtilis*, J. W. B. for the markings are coarse, being readily resolvable with a $\frac{1}{2}$ of an inch. The centre is not commonly marked like *Hyalodiscus subtilis* but the dots are all over the valve and look plainly hexagonal in shape.

Hyalodiscus subtilis was founded by Bailey in his Notes on new species and localities of microscopic organisms, Washington, 1858 page 10, fig. 12. The figure is a good one for the time and, as I have said, was engraved on steel, by John E. Gavit, my friend and successor in the presidency of the American Microscopical Society. It is *Hyalodiocus scoticus*, A. G. and *californicus*, J. W. B. and *Cyclotella scotica*, F. T. K. from the coast of Scotland and on the English coast, where it is small. The large form, which is essentially *Hyalodiscus subtilis*, has never been seen, or at least published, there. It is not found in the phytoplankton of the Atlantic and its tributaries, a treatise on which I am indebted to Prof. P. T. Cleve for. In fact the phytoplankton seems to be free forms and *Hyalodiscus*, and *Trochiscia* of course, are fixed forms. *Hyalodiscus subtilis* was called *Craspedodiscus franklinii* by Ehrenberg. And we can see by comparing the figures of *Craspedodiscus coscinodiscus*, C. G. E. with that of *Hyalodiscus subtilis*, J. W. B. which are given both in plate V. of Pritchard's Infusoria, Ed. 1861, that they are alike. But *Craspedodiscus coscinodiscus* is a fossil form and we do not know how it grows or grew attached to submerged substances as *Trochiscia moniliformis* does, or as *Hyalodiscus* also does now. In fact this is but another example of the danger of describing "species" from fossil forms. Suffice it to say *Hyalodiscus subtilis*, or whatever we may call it, is extremely common in the living state as the Alaskan gatherings show.

Another record which I have to make is of *Biddulphia laevis*, C. G. E. and is of the following. And I find it in my notes of microscopic and other observations made since April 26, 1862, and kept in a book along with illustrations, colored or not, is that on the 18th of January 1890, I made a collection of *Bacillaria* on the road from Elizabeth to Newark, in fresh water, that *Biddulphia turgida*, C. G. E. is a var. of *Biddulphia laevis*, C. G. E. and I remember

that the form then found was a transition of *Biddulphia turgida* into *Biddulphia lœvis*.

The mode in which *Trochiscia moniliformis* grows is this. At first it appears as a sphere made up of a substance which we call protoplasm. It cannot be analysed chemically because it changes. At any rate it appears when viewed by the eye as without a shell or hardened loriceæ as it is called, and without any nucleus or therefore any nucleolus. The cell contents are called endochrome and other things. Immediately after these there appear certain minute dots which are of a higher refractive index than the surrounding water, and are therefore differentiated in optical character from the endochrome and protoplasm in which they are in contact. The endochrome is olive colored, these dots seem to be colorless. Soon after or before there appear larger dots which have been called oil globules, for they seem to be oily and colorless and thick in consistence. The first become seeming anthozoa or male organs. The oil globules are seeming ova or female organs. The anthozoa fulfil their purpose by impregnating the ova and then disappear. The ova persist. And the *Trochiscia* has also developed a shell which is siliceous or composed of aluminum silicate. It is now a single *Trochiscia* but is also a single individual of *Melosira nummuloides*, for looking at it carefully it is seen to be on what is known as the side view, or when the valve is exposed to view, to be a clear circle with very fine markings but with no umbilical portion separated from the other or marginal portion. When the umbilical portion appears the name that it goes by is *Hyalodiscus*. Soon it begins to grow by adding another individual to itself, and then another, and another, until a chain is formed. But whilst it does so the shell is not smooth where it joins to the next shell. It is flattened there and the markings are indistinct. This is the umbilical portion. Now can this chain be a *Melosira nummuloides* or a *Trochiscia monili-*

formis. But *Hyalodiscus* was not named then and it had to be placed in a genus *Cyclotella* named from the Greek of a circle and it was so named, and as it was found on algae along the coast of Scotland the name *Scotia* was used as the specific name. But we notice in the figure in *Die Kieselshalligen bacillarian oder diatomaceen*, 1844, that Kuting has given it as growing attached by the edge of the valve and singly, not in chains. This is what I found is the way of growing large *Trochiscia* in the Alaskan specimens and other Pacific coast specimens. Thus the *Trochiscia* grows. Let us see how it multiplies. For in multiplication the product is much greater than by growing. The individual grows in size, that is to say an individual does not increase in size itself but it forms a new individual which is larger than its parent and this is called a gonidium (*gonidia* in the plural). And this may be exactly like the parent, except in size, or it may be unlike, so unlike that it may look another genus,—e. g., *Hyalodiscus*. As Rabenhorst in Tab. x in *Die Süsswasser diatomaceen*, 1853, gives the formation of the gonidium in *Melosira varians* and even the spores, which he gives as possessing ciliae by means of which it swims about when the shell of the gonidium is ruptured as he says is the case. These spores are numerous and move about and disseminate the form so. This seems to be the way *Trochiscia* forms spores.

Amœba Having no Vitality.

ARTHUR M. EDWARDS, M. D.

Amœba is a mass of matter having and possessing remarkable powers of motion. It moves about by something which is known as vitality, for want of a better name, and hence the amœba is reckoned as a living thing, an animal. This was the fact some time ago. But now amœbas are known as vegetables, that is to say the protoplasm of vegetables is known to take upon itself amœboid motion.

But still they were alive, they possessed vitality, and this was the manner vital things were known. They possessed motion which was amoeboid. We can have things which have amoeboid motion but which cannot by any means be considered as living. They are dead matter and have never been alive.

Professor Bernstein explains, in a recent number of *Archiv für die gesammte Physiologie*, an application in which he imparted to a drop of metallic mercury the faculty of real locomotion. One of the most successful forms of his experiment was this: He put a drop of mercury into a suitable dish of which the bottom was perfectly level; then he poured in a sufficient quantity of dilute nitric acid and laid a little piece of potassium bichromate at a distance of several centimetres from the drop of mercury on the bottom of the dish. The yellow solution of the crystal began to spread itself in a circle, and as soon as it reached the drop of mercury, the latter with a brief tremor began to move and then dashed straight to the crystal which it reached in a few seconds; and then, in the liveliest manner, repeated the twitching movements already described. If, in consequence, the crystal moved away in any direction, the drop pursued it, receded and approached, again and again, with a mingled leap and glide while stretching forth long tentacles and quickly drawing them back again. This lively play leads an observer to think that the movements are those of a living organism. They last until the crystal is consumed or the drop has accidentally moved too far away from it. These remarkable phenomena may be considered as adequate support of the view held by the botanist Barthold, the physicist Quincke, and the physiologist Verworn, that the amoeboid and related movements are the result of changes in the tension of the surface of the living substance. Obviously, though, there are still other conditions which can vary largely the movements of the living prototype. It has been known

for some time that lower organisms that are capable of independent movement, such as amœba, infusoria, bacteria, and others, are attracted by certain chemical substances. For instance, if a capillary tube be filled with a weak solution of potassium chlorate or peptone and put into a drop of water in which bacteria are moving, after a few seconds these will be seen hastening to the mouth of the tube where they will assemble. The amœba and the naked little masses of jelly (plasmodia) of the myxomycetes (mucus fungi) creep in a peculiar way by stretching forth their arms or feelers toward the stimulant. This faculty of being attracted by certain substances is called chemotaxis. Chemotactic susceptibility is evidently an advantage for the creatures in question, as it leads them to good nourishment and keeps them near it. Recently Professor Julius Bernstein of Halle, made the discovery that a drop of mercury can make very similar movements. The starting point of his observations was afforded by an experiment made by Poalzon in 1858. The latter put a drop of mercury into a little flat vessel, poured dilute sulphuric acid over it and then laid small crystal of potassium bichromate immediately beside the mercury. The result was a periodical change in the shape of the drop of mercury, which alternately approached the crystal, flattening itself in front, and receded from it. This was due to the fact that, aided by the acid, the potassium bichromate oxidized the neighbouring surface of the mercury and thus diminished the surface tension of the side of the drop. As soon as the peroxide of mercury, which had been produced, dissolved in the sulphuric acid, the surface of the mercury became metallic again and its tension increased. In the first instance the mercury flowed toward the crystal, in the second it sprang back.

I explain this motion not by the physical theory purely nor by the botanical theory, for I do not see how that can explain it, nor by the physiological theory for that neither

explains it thoroughly but by a theory which may be called a mode of motion of being by action, namely by a theory which I used many years ago when I was Professor of chemistry in the Women's Medical College in New York. And let me explain that I then was merely a chemist and explained things by referring them to phenomena of that science. But it is the same nowadays and a process proves to be theory of the mode of motion or force be it by chemistry or any other mode of motion. I said to my students that we can imagine we have a piece of sodium and drop it on the surface of water. It does not sink, but immediately fuses into a mass of matter and assumes motion, moving about in an extremely lively manner, rushing about like what we call a living thing until at last it disappears. Now, what really occurs is this. We drop a solid particle of sodium in the liquid water. When it comes into contact with water it decomposes the water, chemically. The sodium, or what the chemist calls sodium and represents by the symbol or written character Na, caustic soda, or simply soda, or sodium oxide being formed and hydrogen being set free. Now, as hydrogen is a light gas, it escapes upwards, for it cannot go downwards on account of the water which is there. As it is made, the oxygen goes to the sodium and it thereby unites and forms sodium oxide and as is the rule whenever chemical combination takes place there is heat or the temperature rises or it becomes warm, hot, and this heat is high enough to fuse the sodium oxide. As the sodium oxide is fused it assumes the form of a sphere which stands in the shape of a round ball upon the level surface of the water. Now as all substances assume the spherical form when left to themselves, unaffected by any force, of course the sodium oxide will assume a form approaching the sphere, for gravitation is inactive and it cannot form a perfect sphere. Where it rests upon and presses upon the level water, the gas hydrogen is given off. It is given off in the space be-

tween the water and the spherical balls. It cannot escape downwards and therefore it escapes upwards, and doing it, it escapes on one side of the ball which is thus pushed to the opposite side. This it does until it is stopped by striking against the containing vessel. There it goes up hill, for the water goes uphill itself by capillary attraction. When it has gone up hill until it meets the side of the vessel it tends to roll down again and it is urged on by the escaping hydrogen only to go up hill on the opposite side of the vessel, and so the motion goes on until it is all dissolved and the motion ceases. In this mode, motion starts and is communicated to the sodium oxide. The motion seems to belong to the globule but it is not so.

A New Exhibition Microscope.

In accordance with the original suggestion, and by the generosity of Mr. Wm. E. Dodge, of the Board of Managers, the Garden has been able to place in position, in the systematic museum, a permanent microscopical exhibit including twenty-five microscopes of special design.

The Leitz stand V is used in the construction of these instruments. The foot is removed and the upright support fastened to a base of hardwood 6 x 6 x 1 in. blackened and with beveled edges. The mirror swings in two axes, and the square stage is furnished with a wheel diaphragm. The whole stand is surrounded by a case made of sheets of plate glass cemented at the joints. The outside measurements of the case are 4 $\frac{1}{4}$ x 4 $\frac{1}{4}$ x 6 in. The top of the case is not cemented but is held in place by four upright rods which pass down through the base and are fastened by nuts, both on the lower side of the base and on the upper side of the top.

The instrument is furnished with fine adjustment only, and the milled head is removed, allowing the top of the case to rest on the head of the support. The square head

of the micrometer screw projects through a small aperture in the plate and is manipulated by a detachable key kept by an attendant. The upper end of the microscope body is provided with a clamping ring which fixes the tube immovably in place. The ocular is likewise fastened by a set-screw. All joints and openings are sealed with felt in such manner as to be dust-proof. The instruments are fitted with ocular II, and objective 3, giving a magnification of 70, but this combination may be changed from time to time.

The instruments are fastened in pairs to tables of special design, and placed in the west hall of the systematic museum. The objects placed under observation aid in the illustration of exhibits in the cases. Suitable explanations are given by labels placed on the tables at the side of the instrument. The tables are furnished with heavy iron sills to secure stability, and hold the instruments at a height above the floor convenient for the use of the majority of observers.

The entire demonstration will form a most attractive and useful exhibit, and it gives the casual visitor the opportunity of seeing something of the intimate structure of plants.—*D. T. McDougal, in Journal of New York Bot. Garden.*

On the Metallography of Iron and Steel.

WILLIAM H. MERRETT.

It is well known that specimens of both iron and steel, produced under apparently the same conditions, often display totally different properties. This is especially the case with steel, which, on account of its more complex character, is easily affected by small alterations in the conditions of its manufacture. The causes of the variation in properties of similarly-produced samples of metal may often be explained by the aid of the microscope, when all other methods of investigation have failed.

It appears that the metallography of iron and steel has not been developed from petrography, but is a natural extension of the study of meteoric irons. Dr. Sorby, who was one of the first to work on this subject, first established a method of examining opaque bodies under the highest powers of the microscope, and applied this method to different products in the metallurgy of iron. Professors Martens and Wedding were probably the first to systematically examine iron and steel under the microscope. Recently, M. Osmond, of Paris, has done much to develop the science of metallography, and has given us methods by which reliable results may be rapidly obtained. During the past few years much advance has been made in the subject, and already many laboratories in steel-works are fitted with photo-micrographic apparatus.

Although it is possible by the aid of the microscope to learn much about the chemical composition of the metal under examination, it is nevertheless not for this purpose that the microscope is especially useful. Many samples of steel having identical chemical compositions vary enormously in mechanical properties, and it is by the aid of the microscope that the cause of these variations may be explained. Metallography is intended to augment, rather than supplant, chemical analysis. The microscope enables us to ascertain much about the mechanical and the thermal treatment the metal has received, which in commerce is often of the utmost importance. Minute blow-holes, cracks, slag flaws and allotropic changes may also be easily detected by its aid.

The specimens for examination are generally prepared by removing sections from the original sample about three-quarters of an inch square and a quarter of an inch thick. One surface is then carefully ground on a series of emery papers, mounted on plate glass, using ultimately the finest grades which can be produced. As the finest commercial papers are much too coarse, it is necessary to

prepare the final papers oneself. This is done by washing the very finest slime from the best flour emery, mixing it with a solution of egg albumen in water, and brushing it on paper especially free from grit. The paper is then allowed to dry in a cupboard, great care being taken to exclude all dust.

The specimen is rubbed on this very fine emery paper, then on rouge paper, and finally on a wet rouge wheel. The rouge wheel generally consists of a well-surfaced horizontal cast-iron disc, which is driven either by a hand-wheel and belt, or better, by a small electric motor. The disc is covered with clean, non-ribbed cloth, which is wetted and slightly covered with the finest washed rouge. At this stage the specimen becomes lightly engraved, the harder constituents appearing in relief; it should, of course, be quite free from scratches. The structure of the specimen, in most cases, is not shown by polishing only, and must be made evident by physical or chemical processes, which produce different effects upon its constituents.

The constituents are usually shown up either (1) by rubbing the specimen with liquorice juice on parchment, (2) by attacking it with a very dilute solution of nitric acid in either alcohol or water, or (3) by heating it in air to about a straw color (about 24° C.).

Since the specimens are opaque, it is necessary to illuminate them from above. Natural illumination can be used for eye observation only. For oblique illumination we have the well-known parabolic mirrors of Sorby and Lieberkuhn, both of which may be mounted upon the objective. For vertical illumination, Beck's vertical illuminator is extremely useful. This is a small transparent mirror, which, placed at 45° in the axis of the microscope, receives the light from a hole in the side of the apparatus, and reflects it upon the objective; the lenses concentrate the light upon the object. A small prism devised for vertical illumination by Nachet, of Paris, is very good;

pecially when it is found necessary to economize the light.

By far the best source of illumination is a small arc lamp, either hand fed or automatic. When a Nachet vertical illuminator is used, the filament of an incandescent electric lamp placed in front of the slit will often give sufficient light.

If electricity is not available, either incandescent gas, or even a paraffin lamp may be used, but the time of exposure will be much longer. Where long exposures are necessary, it is imperative to have the apparatus fitted so as to be quite free from vibration. When using a small arc lamp, the exposures with Lumiere's plates, sensitive to yellow and green, vary from two to five seconds; with a paraffin lamp under similar conditions, it would probably be necessary to give an exposure of at least twenty minutes. Faults in the construction of the apparatus, which are hardly noticed when the exposure is short, become very formidable with a long exposure.

The camera may be either vertical or horizontal; for general purposes the latter is much more convenient, and even when using immersion objectives, very little inconvenience will be experienced. It is as well to use a long camera—about seven feet is a very serviceable length—and to have the microscope fitted with a low-power projection eyepiece, the results obtained being invariably better than when a high-power eyepiece has been employed.

The most useful magnifications are the 60, 200, 1,000 and 2,000 diameters. When using a seven-foot camera at full length, and a low-power Zeiss projecting eye-piece, these magnifications may be obtained with the Zeiss 35 mm. projecting, the 24 mm. the 4 mm., with correcting collar, and the 2 mm. immersion objectives respectively. The projecting lens is, of course, used without any eyepiece. Steel for micrographic purposes is viewed as if it were a rock with various minerals distributed through it, and mineralogical names are wisely adopted for the constituents.

Pure iron, being an elementary body, is made up of one substance only, to which the name "ferrite" has been given. It is composed of a number of interlocking crystals.

Steel is composed of iron containing approximately from 0·1 to 2·0 per cent of carbon, and it has the peculiar property of becoming much harder when it is made red hot and quenched. The carbon in steel which has been slowly cooled is combined with a portion of the iron, forming iron carbide, which is known as "cementite." This constituent contains about 6·6 per cent of carbon, and remains bright after a polished section of the steel is attacked by an infusion of liquorice, or a solution of nitric acid. Cementite is very hard, and stands in relief when the steel is polished on the finest rouge on wet cloth. A good specimen of cementite is shown when magnified 850 diameters. Free cementite, however, does not often occur in low carbon steel, but usually assumes the form of "pearlite," which is an intimate mixture of cementite and ferrite arranged in laminae, which are alternately hard and soft. These laminae are very minute, and it is necessary to use a magnification of at least 300 diameters for their identification. The laminae of pearlite often assume a more or less granular form. Pearlite is so called on account of its resemblance to mother-of-pearl. When pearlite is attacked with either an infusion of liquorice or a solution of nitric acid, a voltaic action is set up which causes the ferrite to become dark in color. A steel containing 0·9 per cent of carbon will consist entirely of pearlite; if the carbon be less than this amount the mass will be composed of pearlite and ferrite. If the carbon exceeds 0·9 per cent it will consist of pearlite and cementite.

Cementite may be distinguished from ferrite by its greater hardness. The cementite appears to stand in relief. Ferrite is easily scratched by an ordinary sewing needle, while cementite is not.

Cast iron contains more carbon than steel, the amount

varying from two to five per cent. It practically consists of three varieties—white, mottled and grey. The first variety is composed of pearlite and cementite, the second of pearlite, cementite and a little graphite, and the third of pearlite, together with either cementite or ferrite and graphite. In both cast iron and steel, it very seldom happens that free cementite and ferrite exist in the same specimen.

As it has been before stated, steel differs from cast iron by being capable of acquiring various degrees of hardness, and it is upon this special property that the great value of steel depends. Although there is no well-defined line of demarcation between high carbon steel and white iron, yet the former has a much wider range of hardness than the latter, when submitted to suitable thermal treatment.

The changes in the hardness of a steel are accompanied by a corresponding change of structure. Take, for example, the ordinary process of tempering. Steel is tempered by two processes—(1) hardening by quenching in water, oil or mercury, and (2) re-heating the hardened steel to a given temperature and plunging in water. The quenched structure of steel is composed of a system of interlacing crystalline fibres, and is known as "martensite," after Prof. Martens, of Berlin. The structure of martensite is developed by prolonged etching with an infusion of liquorice, or by an attack of a solution of nitric acid. When a quenched steel is tempered, the interlacing crystalline fibres disappear, and the structure becomes granular. The character of the tempered structure varies greatly with the temperature and the time the steel is re-heated. No name has yet been assigned to the tempered structure.

In practice, the workman tempers steel by watching the various colors assumed by the surface of the metal during the progress of the operation, and when the proper

color makes its appearance the object is suddenly cooled. These tints, some of which are extremely brilliant, are probably occasioned by films of oxide corresponding with considerable exactitude to the degree of heat to which the metal is exposed, and they consequently serve as a tolerably accurate guide in determining the hardness which the object will acquire on being cooled. Although this method is often wonderfully accurate, it must be borne in mind that the colors will appear even when the metal has not been quenched, so that the tint alone is not indicative of a good result. This may, however, be easily determined by the microscope. As the time and intensity of the re-heating increases, the structure more and more resembles that of pearlite, so that it is quite possible to ascertain the quality of the temper from the micro-structure alone.

The hardening of a steel by quenching is not merely due to a change in the condition of the carbon, but also to the molecular transformation of the iron, which may exist in a soft state, and a hard state, the latter being produced, in the case of a high carbon steel, above 800° C.

Therefore, in order to produce a hard steel, the metal must be quenched above this temperature. Should the temperature of quenching be rather low, the structure, instead of consisting wholly of martensite, will be found to contain another constituent known as "troostite" (from Troost, the chemist). Troostite almost invariably occurs in a matrix of martensite, or a mixture of martensite and ferrite. Steels containing troostite are soft, so that subsequent tempering will be useless. They are, however, not so soft as steel containing pearlite. In ordinary steel the pearlite develops at about 700° C. Should a specimen be quenched after the formation of this constituent it will not harden. In practice, steel is generally quenched at nearly 1,000° C., which has the effect of converting the whole mass into martensite.

To be able to determine the quality of the quenching of

a steel is of vital importance, especially in the case of large masses of metal—e. g., the ingots used in the manufacture of ordnance. If a gun-tube is quenched below its critical point it will be soft, and consequently very unsafe for firing purposes, on account of its low elastic limit. The microscope would, however, be invaluable in such circumstances, as it would enable one to say definitely whether the metal had been properly quenched and tempered or not.

If the proportion of carbon in a steel be high, say 1·5 per cent and if the cooling be rapidly effected in iced brine, another constituent appears, which may be scratched with a hard needle, and to which M. Osmond, who discovered it, has given the name of "austenite," after Sir W. Roberts-Austen.

For the engineer, the microscope is especially useful in determining the influence exerted by thermal treatment on varieties of steel of different composition. It is also useful for detecting slag patches, defective welds, and cold rolling effects.

In conclusion, I wish to point out that no attempt has been made to deal at all exhaustively with this subject, only typical cases having been shown, and the method of working briefly described. Both the manipulation and the interpretation of the results obtained require a considerable amount of practice.—*Annual of Microscopy.*

Malaria and Mosquitoes.

So many people have suffered from the attacks of mosquitoes, even in this country, that one of the most attractive addresses delivered at the meeting of the British Association, was that by Surgeon-Major Ronald Ross, the president, Sir W. Turner, being present. Major Ross, in the course of his remarks, said : The particular organism in question belonged to the Hæmæmobidæ, of which there

were three species that found their home in the body of men, two occurring in birds, one in monkeys, three in bats, and perhaps some in frogs. These parasites, it was found, inhabited at different times two very different hosts —a discovery which would not have been expected, for although it was known that the organism which caused the Tsetze cattle fever was carried by insects, it was not known that the organism actually lived in the body of the insect. Major Ross described its method of reproduction by division, and pointed out that in addition to this simple means of reproduction there was a much more complex method of reproduction. At one stage in the development of the organism there was produced a tiny thread, which sprouted from the side of what was really the male cell. The thread which he called a blastocyte was eventually cast loose and entered into another class of cell which was really female, and there great numbers of similar threads were formed. At a certain stage this cell burst and the threads were set free in the liquid blood of the patient. It was the toxin which set up the fever, and the moment of this breaking of the cells and the scattering of these threads was the moment of the setting in of the fever. Then came the shivering, and subsequently the sweating stage, at which the patient got rid of the toxin. The threads gave rise to spores, and the whole process was gone through again. Hence arose the well-known periodicity of malarial fever. If the finger of the patient were pricked and blood drawn, the whole process of the development of these creatures could be watched under the microscope.

If a mosquito bit a patient suffering from malaria fever it sucked up into its stomach some of these blastocytes or threads. These continued to multiply in the interior of the stomach and accumulated in the form of small cells adjoining the wall of the stomach, the membrane of which was eventually penetrated by the cell, and the latter be-

came received in the system of the mosquito, in the juices of which it formed more blastocytes. Major Ross remarked parenthetically that he was warned by Prof. Herdman to be very careful as to the terms he used, and he therefore said "juices of the mosquito," and not "blood of the mosquito," though he was convinced that the juices circulated. The blastocytes multiplied within the mosquito exceedingly, and were to be found even in the head. At the lower side of the head were found a number of cells, which he had discovered to be the salivary glands of the creature, and in these the blastocytes were also to be found. A mosquito thus affected, in biting a person deposited in his system a blastocyte, and the seed was sown for the malaria. To prove that the mosquito was the means of the conveyance of the disease, Major Ross said that two forms of gnats or mosquitoes were found in England. The common one was that known as Culen, and the less common was Anopheles. The larvæ of Culex were well known, and one could not place a tub of water in his garden and allow it to remain there for a few weeks in the summer without finding the larvæ of Culex wriggling about in it, and sinking suddenly to the bottom when the water was disturbed. These larvæ were provided with an air tube, and hung head downwards from the surface. The larvæ of the Anopheles were laid in pools of water or in wet soil, and they were without the air tube, and lay full length upon the surface of the water. All the Anopheles which were found in England were capable of conveying malaria; but it was, of course, owing to the extinction of the malarial parasite, very difficult for the mosquito himself to become infected. It was necessary for people to dispossess themselves of the idea that these creatures only lived for an hour or two or a day or two. He had kept them alive for a month in tubes, in the most artificial way, and other observers had kept them alive for six weeks, feeding them only on bananas. His own, and he had

kept thousands, had been fed on both bananas and blood. They certainly wintered in the South of England in cellars and outhouses, and he believed that they lived for a year. The females only bite, and their favorite dining-hour was at night, though they would bite at any hour if one gave any encouragement. Men might be bitten by *Anopheles* without being conscious of the fact at the moment, but the *culex* gnat was more blundering, and buzzed about one's ears and face. Blood appeared to be necessary to the maturation of the eggs, for he had never known eggs laid by a female which had been fed only on bananas. The great majority of the black babies in Tropical East Africa were infected in childhood by the malarial parasite, and it was easy, therefore, for the infection to be carried to any white man. In conclusion, Major Ross showed a plan of Sierra Leone indicating with spots the places in which the larvae of *Anopheles* had been found. The method of reducing the prevalence of malaria was, of course, to destroy the places for the growth of the larvae of the mosquitoes by a proper system of surface drainage.

—*Eng. Mech. and World of Science.*

The "London" Microscope.

Messrs. R. and J. Beck, Ltd., are just introducing a new microscope which they say "is the most important move we have made in microscopy for 15 years." The instrument is on the accepted foreign model and equal in all respects, at the same time being vastly cheaper in price.

The base and pillar are so designed that although the Continental model has been retained, the position of the inclining joint has been so placed as to give greater stability when the instrument is in the horizontal position, whilst not interfering with its vertical rigidity. The base actually rests on three feet, into which are inserted cork pads to prevent scratching of the table. These can be removed if desired.

The stage is square, the upper surface being faced with an ebonite surface. In the instruments Nos. 1125 and 1129 it measures $3\frac{1}{2}$ in. by $3\frac{1}{2}$ in. In the large model instruments Nos. 1152 and 1153 it is specially large for the examination of Petrie dishes or culture plates, and measures 4 in. by 4 in. A removable mechanical stage can be attached at will to any of these instruments without returning the microscope to us.

The coarse adjustment is by spiral rack-and-pinion, so accurately fitted that even comparatively high powers can be focussed thereby. The fine adjustment, which is very delicate, consists of a triangular prism upon which slides smoothly a solid metal sleeve which fits this prism so perfectly that there is no lateral motion.

The adjustment is obtained by a fine micrometer screw actuating a supplementary pointed rod which impinges upon a hardened steel plate.

The limb of the microscope is so designed that there is a plenty of room for the fingers when turning the milled heads. In the larger model instruments, No. 1152, 1153, the milled head, which is of a larger size, is graduated to 1-2,000 in, for measuring the thickness of cover-glass, ctc. and a folding indicator is attached to the limb of the instrument.

The body tube of the microscope is 140mm. long with a graduated draw-tube which extends the length of 200mm.

A double mirror on a swinging arm is provided, and in microscopes Nos. 1125, 1129, an iris diaphragm accompanies each instrument. The latter is made with a fitting at the top into which may be fitted a small Abbe form condenser. The instrument, No. 1129, is provided with a spiral focussing and swing-out adjustment. The larger model microscope, No. 1153, has the same substage as No. 1129, while the No. 1,152 has a complete rack-and-pinion focussing substage with centering adjustments.

The Abbe condenser is supplied in two sizes—in both

cases with an aperture of 1. N.A., which is the maximum where the condenser is not used in immersion contact with the under surface of the slide. The small size Abbe condenser fits into the fitting of the iris diaphragm which accompanies each instrument. The large Abbe condenser has an iris diaphragm and swinging arm to carry a ground glass or a blue glass (one each included). A green glass, giving approximately monochromatic light, or a series of patch stops may be supplied.

The Beck achromatic condenser has an aperture of 1. N.A., is a corrected achromatic system with an aplanatic aperture of about .9 N.A., and is both for spherical and chromatic aberration a more perfectly corrected condenser than the Abbe form. It gives finer results, but requires to be more carefully centred and adjusted.

Wider angle condensers are supplied, but, of course, can only make use of their greater angle when they are used in immersion contact with the under surface of the slide.—*Eng. Mech. and World of Science.*

A New Method of Counting the White Corpuscles.

Kourloff (Vratch) has devised a new method for counting the white corpuscles of the blood, which has been tested by him in conjunction with Solovieff: Four or five cubic millimeters of blood are drawn directly from the finger into a graduated mixing pipette, and immediately blown upon the side. Two dry cover-glass specimens are now prepared and are stained in the usual way, and their area measured by means of a network of lines. The white cells are then counted on both cover-glasses and the area examined is measured by means of the movable stage and Ehrlich's diaphragm. From the figures thus obtained the number of cells in the whole specimen is calculated, and from this result the number of white cells per cubic millimeter is determined, the volume of blood used being

known. The authors have also devised a pipette for drawing the required amount of blood. This consists of a graduated glass tube to the upper end of which is attached a short rubber tube. A special clamp, consisting of two little metallic wheels between which the rubber is compressed is placed on the latter at a short distance from the end of the glass pipette. By turning the wheels with the thumb the rubber tube is elongated and the blood enters the capillary tube. It is best not to blow out the entire quantity of blood in the pipette, because if this is done some air will get into the drop on the cover-glass and prevent the successful counting. The amount of blood that remains in the capillary tube is to be subtracted from the amount first drawn into the pipette. Care must be taken that the film of dry blood is thin and evenly spread over both cover-glasses. The writers assert that they could count from one to two thousand more white cells by this method than the same specimens of blood showed by the old method in the Thoma-Zeiss cell. The dilutent in that method they say changes some white cells, and some of them perish in the process of preparing the blood for counting. These disadvantages are absent in dry specimens; for even if some of the cells are destroyed in the preparation of the specimen, they leave shadows upon the slide that can easily be recognized. The new method has also the advantage of allowing the operator to work without haste, and the results of an examination can be verified by a recount at any time.—*Drug Circular.*

Wanted.—Earth containing diatoms from Redondo Beach for a European subscriber who offers cash, or, in exchange, Hungarian diatomaceous material from St. Peter. C. W. S.

Wanted.—Microscopic preparations illustrating the histology of petals and sepals. Would like to get a full set for John H. Lowell, Waldoboro, Maine.

Universal Sizes.

Annual of Microscopy, London, Eng.

In the year 1882 the Royal Microscopical Society advised that standard sizes for the diameters of eye-pieces should be fixed, and those recommended were:—For large microscopes 1.35" diameter, and for small instruments .92" diameter. The latter has become practically universal, and is now used by nearly all the Continental and by many British manufacturers in students' microscopes. The larger size never really became a standard one, and makers have created sizes exclusively their own, without, from a microscopist's point of view, a good and sufficient reason.

It may be that they have felt that trade would be retained in their own hands if they used exclusive sizes, but the day for this has gone by, and the exigencies of the microscopist must have precedence over the commercial rapacity of the microscope maker. It has, in fact, in recent years, been surprising that no co-operation has taken place so as to bring this state of things to an end.

We have hitherto regarded the Continental makers as beyond the pale of conversion to any standard system, and many people rubbed their eyes when it was announced at a recent meeting of the Royal Microscopical Society, that Reichert had supplied the universal size of substage fitting to a new model of microscope that was exhibited. Not many days after this it was hinted that the sub-committee of the society had under consideration the standardization of the substage and of the internal diameter of the draw-tubes of the microscope, and at their meeting on December 20th, the following resolutions were adopted by the Council:—

1. That the standards adopted by the Council in 1882 be withdrawn.
2. That the standard size for the inside diameter of the substage fitting be 1.527 inches = 38.786 mm.

3. That the gauges for standardizing eyepieces be the internal diameters of the draw-tubes ; the tightness of the fit being left to the discretion of the manufacturers.

4. That the following four sizes of the internal diameters of the draw-tubes be adopted :

R. M. S. No. 1 .9173 inch = 23.300 mm.

R. M. S. No. 2 1.04 inches = 26.416 mm.

R. M. S. No. 3 1.27 inches = 32.258 mm.

R. M. S. No. 4 1.41 inches = 35.814 mm.

5. That a set of plug and ring gauges of all the above sizes be kept in the Society's rooms, and that the public on payment of a small fee be allowed to inspect them.

6. That the Society acknowledges with thanks the assistance received from many firms in reply to circulars.

NOTES.

1. The substage gauge adopted is that which has been used by the English trade for many years past, the variation amongst different makers being not more than a few thousandths of an inch.

2. R. M. S. No. 1 is the Continental gauge.

3. R. M. S. No. 2 is the mean of the sizes used by the English trade for students' and small microscopes.

4. R. M. S. No. 3 is the mean of the sizes used for medium-sized binoculars and others of a similar class.

5. R. M. S. No. 4 is the maximum size for long binoculars.

6. In all probability the eyepiece cap, and apparatus to be used above the eyepiece, will be standardized in a few weeks.

The above requires practically no comment. That the Royal Microscopical Society is the fit and proper body to arrange such a matter is beyond dispute, and if the influence of its Council and members is not sufficient to cause the matter to be taken up by manufacturers, then nothing further can be done, but we venture to hope that the labors of the sub-committee will not be fruitless.—*An. of Microscopy.*

Notes on Microscopy.

JOHN. H. COOKE, F. L. S., F. G. S.

BLOOD.—Permanent preparations of blood—amphibian for preference as the red cells are so large and contain such prominent nuclei—may be prepared by allowing fresh blood to fall drop by drop into a solution of osmic acid (two per cent acid solution, one part; one per cent solution of sodium chloride, two parts; distilled water one part). The solution should be constantly stirred while the blood is dropping. Allow the blood and acid to stand one night, and then wash the acid away with distilled water. Add alcohol, then clove oil, in which the blood may be kept indefinitely. Before the alcohol is added, the nucleus of the corpuscle may be stained in alum-carmine; or the whole corpuscle may be stained in aniline blue. Mount in balsam.

WARM SLIDE.—A warm slide is an indispensable piece of apparatus to the student of histology. In the study of amœboid movements it is essential unless a suitable spot in the frog's web can be found. To make a warm stage, take a strip of copper the size of a glass slide, and make a diaphragm opening in the centre. Attach a long strip of copper to this—or the whole can be of one piece—sufficient to project about four inches over the edge of the stage of the microscope. The flame of an alcohol lamp heating the end of this strip will, by conduction, heat the whole piece together with the slide placed on it. A drop of blood being prepared for examination in the usual way, make a ring round the cover-glass with oil to prevent evaporation, place on the warm stage, apply the heat, and the leucocytes can be studied in their movements with higher powers and with greater ease than in the frog's web.

WATER BATHS.—A water bath is another very necessary adjunct where a certain very moderate degree of heat is not to be exceeded. Few persons fully appreciate the

difficulty of regulating or even estimating the temperature of an object held over a naked flame, and mischief is often done before the operator is aware of it. A serviceable water bath is easily extemporized out of an old fruit can and a small beaker glass. This serves for exposing material and preparations to a temperature lower than that of boiling water. Where slides are to be so heated, the simplest contrivance is a flat tin box, with all the joints (cover and all) tightly soldered. A small tube closed with a cork serves to admit the water.

Notes on Microscopy.

F. SHILLINGTON SCALES, F.R.M.S.

MATERIAL FOR BOTANICAL STUDY.—The obtaining of suitable material for botanical study has been a difficulty that the individual worker has had to contend against equally with those in charge of our laboratories, science schools, and colleges. For some time past zoology has had an advantage over botany in this respect, and we therefore note with great satisfaction a new departure by Messrs. J. Backhouse & Son, Limited, of the well-known nurseries at York. This firm has for three generations been directed by gentlemen of high scientific ability, and during this period they have devoted a large amount of their time to the study of the conditions affecting the naturalization and distribution of plants, especially those for which are not indigenous to Great Britain. As the result they possess in their York nurseries a larger number of species, representing tropical and sub-tropical as well as Arctic floras, than almost any firm in the country. They have now decided to undertake systematically the collecting and preparing of botanical material for scientific purposes, and have opened a scientific department under the special superintendence of Dr. Arthur H. Burtt, D. Sc., B. Sc. They have further issued an extensive classified catalogue which, though only meant as a preliminary list, covers the whole field very completely. It comprises the Myxomycetes, Schizophyta, Diatoms,

Desmids, and other *Algæ*, both fresh-water and marine, *Characeæ*, *Fungi*, *Lichens*, *Hepaticæ*, *Musci*, *Filicinæ*, *Equisitinæ*, *Lycopodinæ*, *Gymnospermæ*, and most of the more important orders of *Angiospermæ*. The material will be supplied either fresh or preserved; and in the latter form it is intended to keep in stock large quantities of material, so that students will be independent of the season for their supplies. Special attention will be devoted to microscopy, and high-class and guaranteed preparations illustrating the more important structural features of the principal types will be generally available.

MOUNTING.—Objects, other than crystallizations, for polarized light are generally mounted in Canada Balsam. The mounting of hairs is quite simple, though it is advisable to give them a preparatory soaking in turpentine or benzole beforehand. They make striking objects when crossed or interwoven. Mr. Cole recommends the following procedure in mounting fish-scales:—"Scrape the fish from the head towards the tail; if scraped the other way, nearly all the scales will be injured. Place the scrapings in a bottle of water, shake well, pour off the water, and repeat the process until quite clean. Examine with a microscope; and if you find that the scales are not clean, pour off the water, add liquor potassæ, and soak for an hour or two. Then wash away the potash with repeated changes of water, dehydrate in the methylated spirit, clear in clove oil, and mount in Canada Balsam. Sometimes fish-scales buckle up in spirit and they will not lie flat. When this happens, put them into water again, and soak a little while; then place them on a slide, and put another slide over them, press down until quite flat, and tie the two glasses together with twine, and place them in a vessel of methylated spirit to dehydrate under pressure. This method will answer for all tissues that twist during process of dehydration."

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tar products. It has been used in the relief of rheumatism and neuralgic pains and in the treatment of the sequelæ of alcoholic excess. AMMONOL is also prepared in the form of salicylate, bromide, and lithiate. The presence of Ammonia, in a more or less free state, gives it additional properties as an expectorant, diuretic and corrective of hyperacidity.—*London Lancet*.

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AMMONOL is one of the derivatives of Coal-tar, and differs from the numerous similar products in that it contains Ammonia in active form. As a result of this, AMMONOL possesses marked stimulating and expectorant properties. The well-known cardiac depression induced by other Antipyretics has frequently prohibited their use in otherwise suitable cases. The introduction of a similar drug, possessed of stimulating properties, is an event of much importance.

AMMONOL possesses marked anti-neuralgic properties, and it is claimed to be especially useful in cases of dysmenorrhœa.—*The Medical Magazine, London*.

Ammonol may be obtained from all Leading Druggists. Send for "Ammonol Excerpta," a 81-page pamphlet.

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5	Foraminifera in Sands, 24 "	\$.50	" "
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1	Spicules of Sponges 18 "	\$.50	" "
1	Spicules and parts of Echinodermata 18 "	\$.50	" "
1	Zoophytes 18 "	\$.50	" "
1	T and L Sections of Horns, hoofs &c. 18 "	\$.50	" "
2	Hairs of Animals 24 "	\$.50	" "
1	Skins and Scales 24 "	\$.50	" "
6	Miscellaneous objects (Zoological) 24 "	\$.50	" "
2	Starches 18 species in each series,	\$.50	" "
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CONTENTS.

On a Direct Method of Demonstrating the Muscular Function of the Diatom. Cunningham	299-305
A Few Notes on the Microscope in the Drug Store. Whelpley.	305-308
Collection, Preservation, Staining and Mounting, Tube-casts, Urinary Deposits, etc	308-310
Photo-Micrographic Apparatus. Penny	310-314
Extracts from English P. M. Society's Note-Books ; Podura and other Scales. Bryan.	314-319
NOTES BY SHILLINGTON SCALES.—Mosquitoes and Malaria ; Role of Insects as Disease carriers ; Regeneration of Earth- worms ; Artemia ; Mechanical Stage ; Mounting in Balsam ; in Glycerine ; Ringing.....	319-326
Manual of Clinical Diagnosis. Simon.	326

On a Direct Method of Demonstrating the Muscular
Function of the Diatom.

K. M. CUNNINGHAM.

During the month of May, 1897, I had opportunities for prosecuting some studies in relation to diatom biology, being a continuation of previous efforts successively reported upon, and as some recent expedients led me to results of unusual interest, I have thought proper to report the same.

For at least five years antecedently, I had become interested in the study of the structure of decayed woody substances, and in the course of the study, I found out that if a piece of dry, decayed wood was crushed into a fine powder; and that if the rays of the sun were focussed on



the same by the aid of a small lens, the powder would ignite and burn, nearly as freely as the fungus substance known as "punk." By the aid of a spark produced in this way, it would be possible to light a pipe or cigar in the absence of matches. Further, these decayed woods always reveal something of interest in their cellular structure when examined as powder or splinters under the microscope.

During my studies in May, having a living diatom-gathering under examination, and knowing that I could, from my supply, place in the field, a hundred or a thousand living diatoms at a time; it incidentally occurred to me to mix a small quantity of the powder of decayed cypress lying near at hand with the living motile diatom on the slide. Acting on this thought, I discovered, that by the aid of this decayed wood, everyone has it in his power to study "ad libitum" every characteristic of motion associated with the *Navicula* species of diatoms. As all of the larger forms, known as *Navicula major*; *N. nobilis* and *N. viridis*; display all their motile functions in a similar manner, they may be conveniently and agreeably followed under a magnification of two hundred diameters. This permits a field for three or more diatoms to be observed alternately or simultaneously, whereas under six hundred diameters, one diatom would occupy most of the field and multiply the efforts of the observer to retain it constantly under study.

In order to illustrate the manner of proceeding, we will assume that there are some fifty or more *Naviculæ* on the slide, perfectly free from all other matter except possibly some small rotiferæ, and that upon the slide there had previously been put a minute layer of the wood-dust, just such a layer as would adhere when the slide was turned over and tapped so as to dislodge such particles as might not be in contact with the surface of the glass slip. On beginning his observation, one would immediately

note that every *Navicula* crossing the field or entering therein would be actively engaged in picking up the minute wood particles, and rapidly as well as automatically transporting them in any direction on its surface, transversely back and forth, rejecting or attracting other contiguous particles, with either a suction-like or a projecting impulse to dislodge it. Particle after particle may be thus picked up at the advancing end, and transferred until a tangle of the particles becomes bunched together at the rear end, where it is dislodged and dropped. Should one have seen this much, and have followed it for half an hour or so, he would then have satisfied himself as to many points, long a source of discussion and apparently missed entirely by writers who have studied the biological characters of the diatoms through a series of years. He would then be perfectly satisfied that the diatom had a particularly active epidermis, with a decided muscular function, in the sense of an apparent volitive power, that enables its possessor to take hold by a touching contact, to move the particles in a positive or negative sense, and to eventually reject the load, incessantly repeating this evidence of energy expended for some useful functional purpose.

Now, what has been stated above, may not appear to be so wonderful to the reader, but something that cannot be incidentally overlooked while the study is in progress, is to the effect, that while the field at the beginning is uniformly strewn with the minute transparent amber-colored particles of wood cells, as the diatom casually attaches a particle or particles to its body, the color of the particle quickly changes to a violet shade, passing afterwards to a bluish violet, and when a group of the particles have been massed together towards the rear end, the amber color has vanished and we notice bluish and violet shades, in the picked-up particles. While this change is thus taking place, the mind associates the phenomenon

with an active chemical action, as if some gaseous body was blown into the texture of the particles, as it increases and grows in color while under observation.

When the phenomena derived from experimental suggestions indicated herein are fully appreciated, one is in a better position to discuss the question of the vegetable or protozoan characters of such phenomena. The demonstration of the phenomena postulated herein, is of so certain and accurate a nature, that any microscopist, having average skill, can demonstrate all of the varied phenomena of motion, muscular energy and color changes, to an audience of a hundred or more. It would be easy with a micro-projection lantern to project the working diatom in a field two feet or more in diameter, when the *Naviculae* would have a linear extension of fifteen or more inches, and as there is a strong color contrast between the diatoms, amber particles of wood and the violet hues after transport contact, the phenomena would appear on the illuminated projection disc, the same as in the field. Then everyone according to his experience might interpret the character values of the biological phenomena thus presented and demonstrated.

To enable one so inclined to make the verification for himself with a microscope, the following suggestions, if followed, produce successful results. First, secure from any locality where the larger living *Navicula nobilis*, *major*, and *viridis* are known to occur, a quantity of the crude material. Water algæ, plants or muds are collected into a wide-mouth bottle about three and a-half inches in depth and a few inches wide allowing this crude material to occupy one half of the bottle, the remainder to contain water. The bottle is then allowed to stand exposed to open daylight and air. Within a day, the diatoms will occupy the clear water, swimming free in suspension and attached to the sides of the bottle more numerously. On each successive night, or day as the study may per-

mit, from the central clear portion of the water in the bottle remove with a pipette, enough water to fill a small circular white china saucer. When the little saucer is filled, the large diatoms in the clear water will settle to the bottom. Then oscillating the sides rectangularly, will mass the diatoms to the center, and gently twirling will tangle them or gather the diatoms to the center, and their presence will be easily recognized by the unaided eye as a dark spot. There will be in the mass nothing but living shells with their greenish endochrome, offset by the white of the saucer. No dead shells will have been removed from the bottle. Only such forms as were floating in the clear water, on removal with pipette, will appear.

When the little clot of diatoms is gathered together, the water in the holder is carefully poured off until a couple of drops only are left. The diatoms are then whirled together again, and can be readily dipped up and deposited on a suitable slide. Shortly before doing this, take a small piece of the so-called rotten pine or cypress wood, and scrape it very gently transversely across the grain so that no coarse particles will fall with the fine dust. Place the dust on a clean dry slip, and by tapping drive the powder so as to cover a space of $\frac{1}{4}$ inch wide. Tap the slide so as to dislodge any excess of wood dust, as the layer should be uniformly and evenly spread. If the dust layer is too dense, the diatoms will plough through it and be obscured. Next apply the drop from pipette containing the living diatoms over the center of the dust layer, when all the diatoms will be easily found and easily followed in their movements with a $\frac{1}{4}$ inch objective. The slip may be supported on any rigid metal stage, but for inspection under a $\frac{1}{2}$ inch objective it will be necessary, in the absence of a regular movable glass stage plate, to support the glass slip on a separate piece of glass of about $3\frac{1}{2}$ inches square and $\frac{1}{4}$ inch thick for weight. The supporting stage glass must be constantly moved by the hand to insure a con-

stant unbroken view of the moving diatom under study. In this wise, there will be no tremor or hitching of the slide, but it may be moved by minute impulses without variation for hours at a sitting. As the field of view under a $\frac{1}{2}$ objective is about .02 inch, steadiness will be essential. Any condenser, or a hemispherical lens, as an aid to the concave mirror, will give a field as bright as necessary. The concave mirror alone, will answer in the absence of substage condensers of any form.

While engaged on these recent studies having a bearing on the biology of the diatoms, Mr. Lewis Woolman casually sent me a paper by T. Chalkley Palmer entitled: "Demonstration of absorption of carbon dioxide, and the generation of oxygen by diatoms," being a reprint from the Proceedings of the Academy of Natural Sciences of Philadelphia, February, 1897. In his experiments he made use of the chromogen of logwood, called Hæmatoxylin. He discharged the red color of the liquid Hæmatoxylin by blowing the breath into the solution when the carbon dioxide reaction turned the liquid into a yellow-brown color. While under the influence of nascent oxygen, as elaborated by the diatom, the light red hue of the hæmatoxylin deepens momentarily and ends by becoming a very deep blood red which latter red color may be discharged by carbon dioxide. These reactions, as noted by Mr. Palmer, may have a bearing on the action of the living *Naviculae* on the minute yellow or brown particles of wood as previously detailed in this paper. It is probable, however, that the reactions observed by Mr. T. C. Palmer could be shown fully as well under the microscope, as in the manner indicated in his paper. A number of living diatoms could be watched in the field while immersed in a solution of hæmatoxylin before and after treatment with carbon dioxide. Mr. Palmer's paper is condensed into three pages, with a diagram indicating how the test should be made. It is stated that he used the non-motile

species, *Eunotia major*, with which to conduct the oxygen reactions.

I have sent to the N. Y. Microscopical Society a prepared slide of the diatoms which have been my principal source for study of the various motile characters and also specimens of the decayed wood adapted to the purpose of the demonstration. Wood of a similar character is widely distributed in the United States, and is easily accessible to any ones who seeks it. I also enclosed a slide containing *Eunotia diodon* and having *Navicula rhomboides* in profusion, upon which material in the living state I have made studies of interest. This latter material is derived from a natural spring 330 feet above the level of Mobile Bay and in the freshly gathered state of the material it was easy to isolate hundreds of minute *Hydra viridis*, whose bodies were 3-100 inch long and tentacles 1-100 inch long. This was the first time in twenty year's collecting in every character of waters that I had succeeded in finding a specimen of *Hydra*. With this special gathering, I was enabled to study many of the aspects of movement, budding, capture of prey, etc., all of which agreed with the well-known histories of the *Hydra*, from the time of Trembley of Geneva, to the latest writers of the day.

Mobile, Alabama, June 5, 1897.

A Few Notes on the Microscope in the Drug Store.

I have on previous occasions brought before this association the subject of microscopy. It is not my purpose at this time to enter again into the general consideration of the study. I shall by demonstration rather than by use of words illustrate a few of the many simple tests that can be made with a cheap microscope.

I desire to especially impress upon you that all of the work of the pharmacist does not demand an expensive outfit nor require long and tedious training in order to use

the microscope for many purposes. The compound microscopes I have before you cost from ten to fifteen dollars apiece, according to the powers with which they are supplied. They are intended especially for class-room demonstrations and use on such occasions as this meeting. They are, however, convenient in the drug store. An instrument of this kind is very convenient for those pharmacists who care to show physicians and other customers some of the microscopical work they are doing. These simple microscopes range in value from ten to seventy-five cents.

Before beginning the demonstration I will anticipate one question. A simple microscope is not necessarily confined to one lens, nor is it always simple in structure. It may have one or more lenses and quite a complicated mechanism for the purpose of bringing the lenses, object, and light into a proper relationship with each other. A simple microscope is one through which we see an enlarged and erect image of an object. As an example you see the letters right side up when you look at print through one of these simple microscopes, or "magnifiers," or "magnifying glasses," as they are often called.

The compound microscope also enables us to see an enlarged image of an object, but the image is inverted. I will pass around this compound microscope with a specimen of lobelia seed mounted in glycerine. As you rotate the microscope the seeds fall downward. This you can observe by watching the specimen with the naked eye. When you look at the seeds through the microscope they seem to run uphill. This appearance is due to the fact that the image is inverted.

The simple microscope is usually of low power and held in the hand. The compound microscope is generally of high power and provided with a stand. Some simple microscopes, however, are of quite high power, and we can use very low powers with compound microscopes.

The United States Pharmacopœia directs that hydrargyrum cum creta must not have the globules of mercury visible under a microscope magnifying "four diameters." With massa hydrargyri the requirement is "at least ten diameters," and for unguentum hydrargyri "ten diameters." I will pass around two samples of each preparation, one conforming to the pharmacopœial requirement, and one that does not. You see how easily the test is made.

The approximate magnifying power of simple microscopes with a single lens is easily determined sufficiently accurately for ordinary purposes. Focus the microscope on some object and measure the distance of the lens from the object. Divide ten by the number or fraction of an inch, and the result will be the approximate number of diameters which the microscope magnifies. As an example, if the focal distance is two inches, the lens would magnify ten divided by two, or five diameters. One-half inch distance between the lens and the object would give ten divided by one-half, or twenty diameters. If a simple microscope consists of more than one lens, determine the power of each, and add them together for the magnifying power of the combined lenses.

The leaves of senna and long buchu are frequently mistaken for each other by candidates before boards of pharmacy. A simple microscope reveals the oil glands which appear as bright spots in the buchu leaves, and are not found in senna. The general resemblance of these leaves and the difference shown by the microscope are illustrated by the specimens before you. Short buchu and uva-ursi are also sometimes confounded. Here the oil glands in the buchu again distinguish the leaves from the uva-ursi, as shown by the samples I pass around.

Lupulin, of inferior quality, or when adulterated, is easily detected by use of the compound microscope. I pass one microscope with a specimen of pure lupulin, and another showing the drug adulterated with sand. Powder-

ed rhubarb is adulterated by various substances. Here is a specimen containing corn-starch. I accompany it by a mount of pure corn-starch, that you may more easily detect it in the powdered rhubarb. Conium fruit has been mistaken for anise, and severe poisoning resulted. I show you cross-sections of each drug. The row of from fifteen to twenty oil tubes in the anise readily identifies it. If the time permitted I could add many other similar demonstrations. I trust these are sufficient to show you that simple microscopes and cheap compound instruments are useful in the drug store.—Dr. H. M. Whelpley, before the Missouri Pharmaceutical Association.—*Bulletin of Pharmacy.*

Collection, Preservation, Staining and Mounting Tube-Casts,
Urinary Deposits, etc.

In response to a request, we give the following outlines of the processes for obtaining, preserving, staining, and mounting, tube casts, epithelia, etc., from urine, used by the writer in the preparation of slides, now upwards of sixteen years old, but still clear and bright.

If the urine was to come from any considerable distance, the sender was directed to put a small crystal of naphthalin in the container. This substance, while not soluble to any observable extent in urine, has, nevertheless, the property of preserving it from decomposition for several days. As soon as the sample was received, it was poured into a conical glass, and put in a cold and quiet place (a refrigerator, for instance) to settle.

As soon as the upper two-thirds of the volume of liquid became clear, that portion was drawn off with a syphon or pipette down to as near the line of turbidity as possible, without removing or disturbing any of the solid elements. A few drops of a 2 per cent solution of osmic acid are then added, and shortly afterwards enough of a solu-

tion of eosin to make the whole strongly red. The glass is now exposed to a strong light, and the liquid rapidly darkens, becoming by direct light almost as black as ink, but when viewed by transmitted light, of a dark port wine color. It is then let stand until all the sediment is gathered at the point of the cone, when the supernatant fluid is drawn off, and the glass refilled with distilled water: After settling, the liquid is again drawn off, and another charge of distilled water added to the sediment. This is repeated until the added water no longer shows a trace of color, when, after the subsidence of the solid matter, it is drawn off, to the last drop, strips of bibulous paper being used to absorb the minute residue. The best for this purpose is a linen blotting paper, which has been submitted to a certain amount of pressure, and showing diagonal lines of an eighth of an inch, the effect of which is the prevention of separation of the fibers, and their mixtures with the sedimentary deposit.

To the moist sediment, a few drops of glycerin (or if the operator is not expert in making glycerin mounts, of warm glycerin jelly) are added to the sediment, stirred in, and the vessel rotated until the sediment is evenly distributed throughout the mass. It is now ready for mounting, and may be treated exactly as any other glycerin or glycerin jelly mount, the only precaution necessary being, as we have frequently stated in discussing the permanence of glycerin mounts, the use of prepared slips, the cell-walls of which are old and thoroughly dry. The writer prefers for this work a cement made of zinc oxide in a solution of damar in chemically pure (the so-called "crystallizable") benzol, to which, to avoid brittleness, about one per cent of old gilders' size, and a much smaller quantity of castor oil has been added. Such cells reach, very nearly, their limit of shrinkage from desiccation in from eight to ten months, but it is better to give them a year of seasoning. A carefully made glycerin mount, in cells

of this age, is as nearly "permanent" as any mount that can be made.—*Editor National Druggist.*

Photo-micrographic Apparatus.

R. GREENWOOD PENNY.

The usual plan of introducing a table microscope into apparatus for photo-micrography I have always deemed a mistake, and I propose to show how, by a small additional expense, a plant which is far less bulky than that usually supplied by opticians, and which is readily available for both high-and-low-power work, can be easily constructed.

The larger microscope stands of English make having a horizontal optic axis from 8in. to 10in. high, are, in my opinion, ill-adapted for introduction into a photo-micrographic system. They necessitate a raised platform upon which to support the camera, and the illuminating apparatus has to be raised in like manner, making the whole plant unnecessarily heavy, cumbersome, and inconvenient.

The employment of the smaller students' stands whose horizontal optic axis is lower is open to the same objection, only in a less degree.

Then, again, for very low-power work a table microscope is wholly unavailable, as the body tube, even though it be of large diameter, cuts off the peripheral rays from any large object, so that it is impossible to photograph it in its entirety.

The photo-micrographic apparatus which I now commend to the notice of my readers is thus constructed:—The baseboard is 4ft. 1in. long and 5 $\frac{1}{2}$ in. wide and $\frac{3}{8}$ in. thick. Two grooved strips of wood are glued and screwed on to the face of the base-board, and run from end to end. Between these grooves, pieces of apparatus slide freely, and can be firmly held in position by means of clamping screws, such as are used for fixing half-plate

cameras to their stands. These screw into bosses set into the baseboard at intervals of 4 in. apart. The baseboard supports a $\frac{1}{2}$ -plate camera, which, when closed, measures 6 in. high by $5\frac{7}{8}$ in. wide by 7 in. long, having leather bellows capable of 2 ft. 6 in. extension.

The front of the camera is provided with a spiral rack and a pinion, having 6 in. traverse, and the back part of the camera can be pulled out and clamped at any desired distance by means of the clamping-screw. A grooved double reversible focussing screen, $10\frac{1}{2}$ in. by $4\frac{1}{2}$ in., having fine ground glass in one window, and clear plate glass in the other, fits the camera-back, and is in correct register with the plates contained in the double-dark slides, the clear glass pane being useful for delicate focussing with a magnifier.

The camera is provided with several fronts, which are interchangeable. One takes a 5 in. focus Goerz lens, another a 3 in. focus Cooke's lens, and a third, furnished with the R.M. Society's thread, takes Planar lenses, Zeiss's projection apochromatics, or any other desired objective. The latter front is also provided with a simple form of exposure shutter. Another front, also provided with an exposure shutter, has in its centre a light-tight cap, for use with accessory apparatus for medium and high-power work, to be hereafter described. A rotating stage, of simple construction, with brass clips, is carried upon a baseboard having a slot in its centre and a clamping-screw.

This stage can be brought up to any desired distance from the lens employed upon the camera-front, and securely clamped. Behind the stage there is ample space for any condensing lenses, colored-glass screens, heat-filter, limelight jet, or any required apparatus. The apparatus thus set up is available for copying or reducing, or for any low-power photo-micrography according to the lens employed.

For photographing large insects or other large objects,

pond life, etc., ordinary $\frac{1}{4}$ -plate lenses of the rapid symmetrical type or the modern anastigmats can be advantageously used, and by employing the 35mm. or 20mm. Zeiss Planar lenses an infinite amount of low or even medium-power work can be done, for I have found that the ordinary spiral rack and pinion attached to the camera is sufficiently delicate for focussing with these powers.

When, however, medium or high-power work is undertaken, and especially when it is thought desirable to employ apochromatic objectives in conjunction with compensating or projection eyepieces, a special form of accessory apparatus is essential. Messrs. Watson and Sons have constructed this from my designs at a most seasonable cost, and, like all the productions of that firm, the workmanship is throughout excellent. It consists chiefly of a body tube of Continental length, supported upon a metal base, with spiral rack-and-pinion coarse adjustment, and a delicate side-lever fine adjustment, with its milled head conveniently placed upon the right side of the instrument. Its optical axis is only $2\frac{1}{8}$ in. high.

When this apparatus is in use, the stage is pushed up to a convenient distance from the objective employed, and clamped. The object is then focussed in the usual way, the camera front racked up so that its light-tight cap is inserted within another larger cap upon the body tube, which may or may not carry an eyepiece, and the exposure made.

It will be seen that the limb and body tube of the microscope is not attached to the stage, so that the former can be removed and dispensed with when only low-power work is undertaken. With this small and compact apparatus it is possible to photograph any object varying in size from, say, the wing of a large dragon-fly to a bacterium or bacillus.

By keeping the axis of the optical system low—only $2\frac{1}{8}$ in. from the base—the size of the rest of the apparatus is nec-

essarily less bulky, and therefore less expensive, than is the case when a table microscope is employed, which is a set-off against the extra cost of a special form of micro-body and stage. Besides this, unless the operator happens to possess two microscopes, he can ill-spare his instrument for photography, as he needs it constantly for the visual examination of his specimens.

I do not employ a rod and pulley in connection with the fine adjustment, as the limited camera extension admits of this being manipulated at arm's length without inconvenience. In many forms of photo-micrographic apparatus, the microscope and illuminating system are swung upon a centre so as to enable the worker to visually examine his specimens before photographing them. I have adopted the more simple plan of introducing a rectangular prism between the two lenses of a Huyghenian eyepiece, so that the object can be viewed from the side of the microscope, and any desired portion brought into the field of view.

The stage that I have briefly described is a very simple and inexpensive form, with substage tube at the back; but I confess that for medium or high-power work it would be a great comfort and convenience to have also a rotating mechanical stage, backed by a sub-stage having centring screws and rackwork to take achromatic or apochromatic condensers.

One last word about illuminating apparatus. Practically we have a choice between sunlight, limelight, and acetylene or paraffin-lamp light. With the intensely brilliant parallel rays of the sun reflected from a mirror or heliostat, no system of converging lenses is needed save that of the chromatic condenser in the substage. The rays brought to a focus even by a lens of small aperture are liable to injure a balsam-mounted specimen, and I am not certain that they do not act injuriously upon some of the glasses employed in modern objectives. I find, however,

by employing a sheet of plate-glass as a reflector instead of a silvered mirror, that I get ample light, and that no injurious amount of heat is reflected.

Limelight is well adapted for photo-micrography ; but it necessitates so much apparatus—gas-cylinders, regulators, jet, water-tank, condensers, &c.—that I have almost abandoned it. The acetylene light is promising, being very white and actinic, if its disagreeable smell could be avoided. I once remember using an acetylene bicycle-lamp with considerable success. A paraffin flame has scarcely sufficient intensity, except for low-power work, as the exposures have to be so prolonged. On the whole, I much prefer sunlight ; but of course that is only available in the daytime—and in some climates a bright day can never be depended upon.—*English Mechanic, and World of Science.*

Extracts From English Postal Microscopical Society's
Note-Books.

DR. G. H. BRYAN, F.R.S.

PODURA AND OTHER SCALES.—Although “scales of the *Lepisma*” and “scales of *Podura*” find a place in most cabinets, I do not remember a series of objects of this class having been circulated round the P.M.S., and I venture to hope that the present series may afford some instruction to some of the members, and perhaps stimulate them to collect a few of these interesting little objects for themselves. The “*Podura scale*” seems to have produced a great sensation among microscopists about 1873, when it was brought before public notice by the late Mr. Beck ; but since then fresh “test objects” have superseded it to a large extent—viz. *Pleurosigma angulatum*, and then *Amphipleura pellucida*, and these seem to have gradually led to the improvement in lenses required for the study of bacteriology. At the same time these old test



scales are still worthy of attention. About the time of their popularity Sir John Lubbock wrote a "Monograph of the Collembola and Thysanura," published by the Ray Society in 1872, and in the same year Mr. S. J. McIntyre contributed a paper on them to *Science-Gossip* for December 1872 and January 1873. Sir. J. Lubbock's book contains a valuable appendix on the scales of these insects by Joseph Beck, illustrated by fine lithographic plates from drawings by his brother, the late Richard Beck.

Lepidocyrtus curvicollis.—Scales of this insect are often seen in old collections labelled "Podura plumbea," although the generic name *Podura* is now given to an insect without scales, and *plumbea* is the specific name of almost the only one of the *Collembola* whose scales do not show the familiar "marks of exclamation." This is one of the largest species of the genus, and when alive looks darkish. This slide is best examined without the cover on, for which purpose the central part of the ornamental paper is not gummed down. To remove the cover, carefully insert a slip of thin card or note-paper under the edge of the green paper at one side and push the cover out at the other; replace in the same way when done with. If the cover breaks, a fresh one can be inserted. This is really an excellent device for mounting dry objects, and is worth remembering. Note the saltatory appendage from which the name "springtail" is derived; also the curious hump-back projection of the thorax characteristic of the genus *Lepidocyrtus*, from which the specific name *curvicollis* is derived. *L. curvicollis* seems to have two varieties characterized by difference in their scales, which are called "ordinary" and "test" scales. [Students of these scales can purchase them at the opticians, but they are unfortunately becoming increasingly difficult to procure. A slide of the "test" *Podura* only should be asked for, mounted dry. Under the microscope the coarser scales and those actually in contact with the cover-glass, should be examined. In

this latter case the removal of the cover-glass, with its manifest dangers, is not necessary. The *podura* scale, on account of its variability, is not a trustworthy guide to the testing of lenses in unskilled hands, and we put no faith in the exhibition of the inner markings, on which so much stress is laid. They are easily shown by an indifferent lens with a little "stopping down" of the diaphragm, and we believe them to be caused by an optical effect of diffraction. The true nature of the markings on a *Podura* scale has, however, not yet been satisfactorily explained].

Markings are bolder, less continuous, and, when properly focussed, each shows a more distinct bright line down the middle. The "notes of exclamation" are thus more easy to show up separate and distinct than in the ordinary scale. When mounted in balsam the marks become almost, if not quite, invisible. Dr. J. W. Arnold succeeded in detaching the "exclamation marks" by means of an electric spark. *Lepidocyrtus violaceus*, a smaller species than *curvicollis*, like that insect, is abundant in cellars. I refer, with some doubt, to this species.

Both that and the previous kind seem to congregate under or about a sheet of paper placed in the cellar, especially if a little flour has been sprinkled on it. I think they like the shelter, and dislike light. The scales are more irregular in shape and the markings finer, but the lines of marks are wider apart and although the marks are more continuous, their heads are rather more bulbous than in *L. curvicollis*. *Beckia argentea* is a silvery little insect, far smaller than either of the preceding and much lighter in color, which I found in considerable numbers running about stones on a wall at Colwyn Bay at dusk, when the dew was settling. I could only "bottle" one in a specimen tube, because when I tried to get another the first escaped. The scales are very thin and transparent, the markings very delicate and fine, and the "exclamation marks" in

different rows seem as a rule to alternate more than in the preceding species. It is the exceeding tenuity of the scales which makes me refer the insect to the present species (see Lubbock, p. 253). The scale would probably be a good test object if difficulty of exhibiting the markings were the only qualification. *Seira buskii* may give some idea of these scales. They are of leaf-like shape, and have a very small number of exceptionally large "exclamation marks"; altogether they look as if they might be a primordial or ancestral type of *Podura* scale. They might be studied with advantage as throwing light on the structure of the scales of other *Collembola*, the marks, though few in number, being so vastly larger than those of any other species. I found the insect on ivy on a wall by the railway at Shepreth, Cambs, in June 1886. *Tomocerus plumbeus* or *Macrotoma plumbea* is a small, almost black insect, of which I found a solitary specimen under a stone in the woods at Colwyn Bay. This was almost the first stone I examined, and although I looked under many others I could not find any. This is an exceedingly pretty scale, quite different from those of the other *Collembola*, and approaching more nearly to those of the *Thysanura*, *Machilis* and *Lepisma*. It has no "note of exclamation," but instead has regular longitudinal striae, and between them faint transverse striae as in *Machilis*, and also several radiating corrugations starting from the pedicle corresponding to those of *Lepisma*. It thus combines two different types of structure. Its dark color also helps to render it a beautiful object. *Machilis maritima* is an insect about half an inch long, brown with pretty mottlings and white rings on the three long bristles, from which it receives the name of "bristle-tail." It was simply swarming on rocks just above high-water mark outside the mouth of the Dart, in South Devon, on the Kingswear side, but was very difficult to catch and bottle. I got three after trying for a long time. I have also seen it in abun-

dance on the rocks by the shore at Lynmouth, in North Devon. The scales are to my mind prettier than those of *Lepisma* on account of the regularity of their transverse striae, which are absent from the latter. On the other hand, this one has not the radiating marks of *Lepisma*, though both structures occur in *Tomocerus*.

Lepisma saccharina.—This insect is pressed down on a slide instead of the cover. The scales are transferred to a slip of glass, generally the cover-glass, by simply pressing it gently on the body of the insect. And the scales have that side uppermost which was nearest the body. In another slide the scales were pressed down on the cover, and so the uppermost side is the outermost, when the scales were on the insect. It will be seen that the longitudinal marks are on the outer side, and the radial ones on the side next the body.

Mr. Joseph Beck, in an appendix to Sir John Lubbock's "Monograph of the Collembola and Thysanura," states that the longitudinal markings are on the under side of the scale, whilst the outer side bears the radial markings or corrugations.

Mr. R. Beck further pointed out that the crossing of these two sets of markings produced a curious optical effect. At the extremity of the scale where the markings cross each other very obliquely a series of "exclamation marks" like those of *Podura* is produced; but where, as at the sides, the crossings are nearly at right angles, the markings appear like rows of beads.

This optical effect is still more strikingly shown and represents two scales of *Polyommatus argus* lying partly over each other, and producing an appearance very similar to that of a coarse *Podura* scale. Of course, the markings which are uppermost appear continuous, and these are the longitudinal marks where the outer surface has been pressed against the cover. The presence of a little grease on the slide also serves to point to the same conclu-

sion. In a few scales this grease causes the scale to adhere to the cover, thus obliterating the longitudinal marks on the upper slide, and the radiating striæ on the under side will then be seen to be perfectly continuous and far better shown than in any other part of the scale. Where only a very little grease is present, or at the edges of a grease patch, little air-bubbles will be seen in some places to follow the grooves between the longitudinal striæ, showing the thickness of the latter. As *Lepisma* may be found on nearly every kitchen hearth at night time, any reader may verify these facts without any trouble.

Notes on Microscopy.

F. SHILLINGTON SCALES, F.R.M.S.

MOSQUITOES AND MALARIA.—The evidence in support of the theory that malaria infection is due to the bites of mosquitoes, themselves already infected, seems now to have put the matter beyond a doubt. Drs. Sambon and Low have deliberately taken up their residence in the most unhealthy and fever-stricken spot in the Roman Campagna, a place situated in the heart of the swamp, among the haunts of mosquitoes of the genus *Anopheles*, and of which the few dwellings near at hand are inhabited by peasants who are constant victims of malaria. These daring investigators have shown that by avoiding mosquitoes they avoid malaria, but a son of Dr. Manson has given an even more striking example of enthusiasm in the cause of science by allowing himself to be bitten by mosquitoes which had been fed on the blood of a sufferer from malaria in Rome. The mosquitoes were sent to London by Professor Bastianelli, and received early in July. The patient, after being bitten, developed well-marked malarial symptoms, though he has never been in a malarial country since he was a child. He has now recovered, but has thus supplied evidence of the positive kind, as Drs. Sambon and Low did of the negative kind. A letter from

Mr. H. J. Elwes, calls attention now to the necessity of finding out under what conditions mosquitoes do not produce malaria, and mentions that whilst in certain districts in India he escaped malaria by protecting himself with a mosquito curtain, whilst other members of his party who omitted these precautions were attacked, yet in other districts where mosquitoes abound malaria is almost unknown, and these precautions were unnecessary. Amongst recent literature dealing with the subject we may mention a paper on the life-histories of mosquitoes of the United States, published in one of the Bulletins of the U. S. Department of Agriculture, and contributed by Dr. L. O. Howard, U. S. entomologist. Descriptions, with illustrations, are given of all the members of the group met with in the United States, with especial reference to members of the genus *Anopheles*, to which suspicion most strongly points. Dr. Howard advocates the use of kerosene for the destruction of the larva, and calls attention also to the agency of fish in this connection. The July number of the Quarterly Journal of Microscopical Science contains also a number of plates and diagrams by Major Ross and Mr. R. Fielding Ould, of the Liverpool School of Tropical Medicine, illustrating the life-history of the parasites of malaria. Before leaving the subject we may mention that the second malarial expedition from Liverpool has telegraphed home from Bonny, in Nigeria, news of the discovery of another parasite, found in the proboscis of mosquitoes, which causes elephantiasis. This disease is a horrib scourge to millions of natives in tropical countries, and is due to a small worm which lives in the lymphatic vessels. We understand that the discovery has been simultaneously made in England by Dr. Low, and in India by Captain James.

MOSQUITOS AND MALARIA.—Professor B. Grassi discusses the observations of Koch in a recent paper published in Italy. He does not consider they have made any

contribution to the aetiology of human malaria. It also is indicated that Ross's discoveries are suggested by, and are confirmatory of, Grassi's previous results.

ROLE OF INSECTS, ETC., AS CARRIERS OF DISEASE.—For the following summaries we are indebted to the Journal of the R.M.S. Dr. G. H. F. Nuttall, in the Johns Hopkins Hospital Report VIII., 1899 (see also *Lancet*, September 16th, 1899), makes a timely and valuable contribution to the literature of animal and vegetable parasites, and their definitive and intermediary hosts. This occurs in a critical and historical study of the part played by insects, arachnids, and myriopods as carriers of bacterial and parasitic diseases of man and other animals. Among the more important and interesting features of the essay may be mentioned the evidence adduced to establish the connection between flies and the spread of cholera, typhoid and plague; the association of Texas or tick fever with *Ixodes bovis*, tsetse-fly disease with *Glossinia morsitans* and its recent visit to an infected animal; the subject of filariasis, and the mosquito-malaria theory. The bibliographical appendix is extensive.

REGENERATION IN EARTHWORMS.—A. P. Hazen has made some interesting experiments. It has been shown by Spallanzani, Morgan, and Hescheler that a short piece cut from the anterior end of an earthworm dies without regenerating the posterior end, although such a piece often lives for several weeks, or even months. It was not known, however, whether, if such pieces could be kept alive for a long time, they would regenerate; or whether, if regeneration did occur, a head or a tail would develop. By grafting in a reversed direction the small anterior end of one worm upon a large posterior piece of another worm, the small piece can be kept alive for a much longer time. The results showed that a head may regenerate from the posterior end of the seventh segment if it is kept alive for some months by grafting. It seems, comparing this with

other experiments, that the part of the body of the normal worm from which the segments are taken determines what will be regenerated, rather than the directions in which regeneration takes place.

STORY OF ARTEMIA RE-TOLD.—In 1875 W. Schmanke-witsch published in the "Zeitschrift fur wissenschaftliche Zoologie" a famous paper giving an account of his observations on the brine shrimp, *Artemia salina*, from the Bay of Odessa. He stated that by altering the water he could transform *A. salina* into another species, *A. muhlhausenii*; and, more than this, that by the addition of fresh water to the habitat in which *A. salina* lived he could induce a resemblance to the genus *Branchipus* almost amounting to identity. Both results have been repeatedly criticised; the second has been proved inaccurate, and much doubt has arisen in regard to the first. The most thorough-going criticism, however, has been that of W. P. Ainkin, published in Russian in 1898, but now made available to the unlearned in that language by a summary by N. von Adelung in German. Ainkin points out that the various species of *Artemia* which have been described do not rest on a satisfactory basis—not that they are alone in that—and that some of them are merely cripple-modifications of *A. salina*, induced by sudden alterations in the salinity of the water. His experiments showed that if the degree of concentration was slowly and gradually increased, no structural changes of moment ensued. Some light changes were, indeed, observed, but they were only "modifications," not transmissible to the progeny, and disappearing when normal conditions were restored. Moreover, these slightly different individuals were sometimes found together in the same water. It is to be hoped that no one will imagine that the question is closed, but that we shall have more experiments on *Artemia*; in the meantime, however, Ainkin's four general conclusions will be read with interest. The representatives of the genus *Artemia*

show a marked tendency to change, as regards almost all the organs of their body. The form-changes depend mainly on the physico-chemical character of the medium. The changes in individuals which live in salt solutions subject to constant dilution with fresh water do not indicate any transformation of *Artemia* into *Branchipus*; even those in the least salt solutions retain unchanged the characteristics of their genus, especially in the male sex. The concentration of the salt solution has certainly an influence on the length of the post-abdomen, for in dense solutions those with long post-abdomens predominate, in weak solutions those with short post-abdomens.

MECHANICAL STAGE FOR DIAGNOSTIC MICROSCOPE.—Mr. Charles Baker has added to his "Diagnostic" microscope, a detachable mechanical stage by which the whole of a $1\frac{1}{2}$ inch x $\frac{1}{4}$ inch cover-glass can be examined. The lower plate fits on to the stage of the microscope, and has a vertical movement thereon by means of runners, aided by a screw at the top, which, however, gives movement in one direction only. The screw at the side gives horizontal movement for $\frac{1}{4}$ inch both backwards and forwards, and there is a sliding top plate which can be pushed over so as to increase the travel for a further $\frac{1}{4}$ of an inch. The stage is thus well designed for systematic examinations over a large field. The price is \$11.

METHOD OF MOUNTING IN CANADA BALSAM.—It has not only its comparative facility, but also it results in getting the object close to the cover—a point that may be of importance with high powers. It also insures the object remaining in position, very minute objects having a very irritating tendency other-wise to be carried up to or beyond the margin of the cover-glass as soon as it is lowered upon the slide. At the same time, in many cases it is quite safe to mount the object directly on the slide. The process is the same, except that it is generally carried through in one operation. A drop or two of balsam is

placed on the slide, the object worked into it as before. If necessary another drop of balsam is added, and then the cover-glass is gently lowered and pressed down. If the cover-glass is lowered with one edge first it carries air-bubbles away more readily, but it also has a tendency to displace the object. The beginner will find that at first he uses either too much or too little balsam, but he will soon learn to judge this. Excavated cells, which are used for thick objects, but for those not thick enough to require an actual cell, are rather troublesome at first, as, unless there is balsam sufficient to completely fill the cell, an air-bubble will be found under the cover-glass, and it is not always easy to get rid of this without displacing everything.

MOUNTING IN GLYCERINE JELLY.—This is simpler than mounting in Canada balsam, and the preparation beforehand is also simpler. The object must be well soaked in water, and every trace of alcohol, turpentine, etc., got rid of. Owing to the fact that glycerine jelly does not absorb air-bubbles like Canada balsam, it is well to soak in water that has been recently boiled for about ten minutes and allowed to cool. The steeping is preferably done in a stoppered bottle or jar. Prolonged soaking in water is a great aid in getting rid of air-bubbles embedded or entangled in the object, and will generally prove effectual without the aid of an air-pump. It is advisable to soak finally in a mixture of glycerine and water, say one-third of the former, before mounting. The process of mounting is carried out as follows: The slide is placed on the brass table, the object is transferred to its centre by means of the section-lifter, and any excess of water removed by the edge of a bit of blotting-paper, care being taken that the latter does not come in contact with the object itself. By means of the point of a knife, a small spatula, or other similar instrument, a small portion of glycerine jelly is then placed on the object, the requisite quantity being easily

estimated, the lamp lighted and placed beneath the brass table. In about a minute the glycerine jelly will begin to melt, and the lamp is promptly removed. Any air-bubbles should be skimmed off before the cover-glass is put on ; and as the glycerine jelly will only solidify again by cooling, there is no need to hurry the process. After an examination, the cover-glass may be lowered carefully in its place, a clip slipped on, and the whole slide put aside for half a dozen hours or more to set. The excess of jelly around the cover-glass may then be removed by means of a penknife, and the whole slide cleaned by dipping in a saucer of water or holding under a running tap, finally polishing with a bit of rag. Glycerine jelly is often used when mounting in built-up cells, but before doing this it is advisable to run a wetted camel's-hair brush round the cell to make sure that no air-bubbles will cling to the side or bottom. Pure glycerine is not often used for other than temporary mounts, as it will not set ; but a mixture of glycerine and gum arabic, with a little arsenious acid, known as Farrant's solution, is often used, especially in histological preparations, as it dries at the edges. It is best bought, as home-made preparations are not always satisfactory. Glycerine acts as a solvent for carbonate of lime, and should, therefore, not be used for objects of a calcareous nature.

RINGING.—Canada balsam slides do not necessarily need ringing, though our own practice is to ring all our slides, but glycerine slides should be finished off with a couple of rings of gold-size. The process is very similar to that of cell-making. The slide is centred upon the turn-table, taking care to centre by means of the cover-glass and not by the slide, and a ring of gold-size run round the edge of the cover-glass. Care must be taken to just cover the edge of the latter, and not to overlap the slide too widely. Beginners generally take up too much gold-size in the brush. A neat ring is made by attention

to this point, by turning the table at a moderate speed and by raising the brush slightly towards the finish. Old gold-size is best, provided it will run easily. The second ring should be added after the first is thoroughly dry. Finally, a ring or two of Brunswick black or white zinc cement may be run over all as a neat finish. We have seen suggestions for various colored cements to be used for various classes of objects, botanical, zoological, mineral, etc.; but if a distinction is to be made, we think it should refer rather to the mounting medium employed. Our own practice, for instance, is to ring all opaque and dry mounts with Brunswick black, Canada balsam mounts with white zinc cement, glycerine mounts with white zinc cement with a fine black ring in the centre, and other mounts with a white ring on a black one. For use with immersion lenses, all mounts must be carefully ringed with shellac cement, or Hollis' liquid glue, or the cedar oil will dissolve the cement.

MICROSCOPICAL NOTES.

A Manual of Clinical Diagnosis by means of Microscopic and Chemical Methods, for Students, Hospital physicians, and Practitioners. By Charles E. Simon, M. D. Third Edition, thoroughly Revised. 8vo., pp. 558. Illustrated with 136 Engravings and 18 plates in Colors. Philadelphia & N. Y: Lea Bros. & Co. 1900. Price, \$3.50.

It would be a rather difficult matter to take into consideration the various features of such a complete manual. Suffice it to say that it is both systematic and complete. Much new matter has been added, more especial attention having been paid to the recent developments in blood diagnosis. Hemology has received full consideration, and most deservedly so in view of the important factor it has become in the matter of the exact diagnosis of disease. The work is a most valuable and helpful one, and no physician can afford to do without it and the valuable help it will render him.

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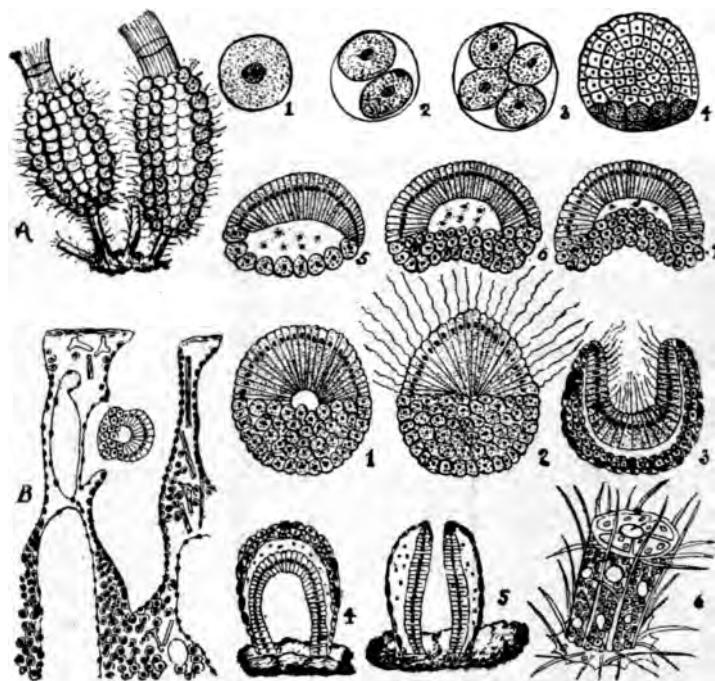
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DEVELOPMENT OF A CALCAREOUS SPONGE.

THE AMERICAN
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CONTENTS.

An Australian Collection of Spouges. Fielder. With Frontispiece.....	327-342
NOTES BY SHILLINGTON SCALES.—C. Baker's New Catalogue; R. & J. Beck's New London Microscope; Development of <i>Balanus</i> ; Glycerine Mounting Medium; Parasites in the Blood	343-349
NOTES. BY L. H. PAMEL.—Pollen in Maize; Fragrant Yeast; Chromogenic Micrococcus; Seed Burying Awns; Diphteria....	349-352
NEW PUBLICATIONS.—Surgical Technology	352
INDEX.....	353-355

An Australian Collection of Sponges.

REV. W. FIELDER, F.R.M.S.

With Frontispiece.

[Read before the Field Naturalist's Club of Victoria.]

Flinders, from its position, has very many attractions. Stretching northwards from West Head, which serves as a kind of break-water between the ocean on the one hand and the waters of Western Port Bay on the other, is a rocky reef which is partly uncovered at low tide. This

EXPLANATION OF THE PLATE.

A.—Colony of *Sycon raphanus* showing two adult individuals and two small ones in the *olynthus* stage. 1,2,3,4.—Ovum in various stages of segmentation; 5, blastosphere; 6,7, pseudo-gastrula.

B.—Portion of a section of the Sponge, *Grantia labyrinthica*, showing an embryo breaking loose from the embryo-containing cavity into a flagellate chamber. 1, blastosphere [late stage]; 2, amphiblastula; 3, gastrula; 4, three-layered embryo; 5, *olynthus* [section]; 6, *olynthus* [external appearance].

reef forms a veritable paradise to the marine zoologist. Its proximity to the shore—it can be reached at very low tide by wading little more than ankle-deep—its sheltered position, and its very formation of fairly loose blocks of moderately soft stone, render it, without exception, one of the most accessible haunts of attractive zoological specimens to be found on the Victorian coast.

I propose, therefore, in a series of short papers, to consider, in their zoological order, three or four groups which are well represented in the marine fauna of this particular locality. And as a mere list of names will be of little interest or value, I hope to describe what may be regarded as typical examples of these predominating groups, and show, as far as space will permit, the relationship of the members of such groups, and the principles upon which the classifications are made.

We commence with the Phylum, *Porifera* or *Sponges*, the reef furnishing examples illustrating the principal sub-classes of this group. Attached to the under surface of the loose stones or safely moored to firmer support between the loose boulders; forming a delicate and, in some cases, gorgeous covering to the rock or a disguise to a tiny crab; growing, plant-like, amongst the delicate sea-grass or upon more vigorous sea-weeds, sponges meet us everywhere. They interest us because of their varying sizes, some being so small as to be almost microscopic in size, others so large that we have a difficulty in enclosing them with both hands. They attract attention on account of their variety in color, some being of deep purple whilst others are of golden hue; some escape notice amongst the seaweed because of their delicate green color, whilst others are white as driven snow. They excite curiosity because of their diversity of form, some of the smallest being perched on a stalk, the body of the sponge being shaped like a small pine-apple, whilst others stand up from the stones to which they are fixed like miniature columns or

chimney-pots ; others again are compact and fan-like in shape, whilst others present delicate finger-like processes to view. They surprise us also because of differences in texture, some being as soft as velvet, whilst others are as hard as wood.

Such diversity in size and color, form and texture, prompt the question, Are they animals or plants?

This same question was asked of Aristotle more than 2,000 years ago, and from his answer we may conclude that he was practically convinced that they were animals. It was not, however, till the end of the last century that English naturalists had any definite theory to put forth on the subject. In 1762, Mr. Ellis, a London merchant, classed them as animals from his observations on the circulation of water through them, and a very early edition of the "Encyclopedie Britannica," 1797, which contains a reference to his work, describes them as a "genus of animals belonging to the class Vermes and order of Zoophytes." It is, however, only in comparatively recent times, and after the most patient labour and exact methods of microscopical study that their true place in nature, as belonging to the great division in the animal kingdom, viz., Metazoa, or many-celled animals, has been definitely established. We shall be able, with the abundant material at our disposal, and with the aid of a strong magnifying glass, a glass tumbler, a sharp razor, a deep watch-glass, and a little patient watching, to discover some of the facts upon which their present classification is based.

One of the most convenient forms to take for examination will be a specimen of the cylindrical variety belonging to the family Syconidæ. These forms are found attached to the under surface of loose stones, and are usually about 1 inch in length, and yellowish-brown in color. They can easily be detached from the stone by the point of a knife, and be transferred to a vessel containing salt-water. Sometimes they attach themselves to pieces of

sea-weed, and in this case the weed and sponge can be transferred together to the vessel, thus affording a better opportunity for examination than if separated from its support.

On reaching home, we shall transfer the sponge to a watch-glass or shallow glass vessel, so that it is well within focus of the hand lens, and after the sponge has become accustomed to its new surroundings a current of water will be seen issuing from the top of it. This will be the more evident if a pinch of powdered carmine is added to the water, and as the current is fairly constant hour after hour, it is evident that its source must be constant too. If the hand lens is powerful enough, smaller currents will be seen setting in towards the sides of the sponge and these form the source of supply to the larger current. The actual course taken by the current is not very evident, however, till we remove the sponge from the water, and with a sharp razor make a longitudinal cut through the very centre of it. This reveals the fact of a central cavity, the *gastral cavity*, extending from the bottom to the top of the sponge, the cavity being closed at the bottom and open at the top. Another fact, not quite so evident, however, can be made out, namely, that there are tiny breaks in the continuity of the wall which lead into minute open spaces. This rough-and-ready method of examination will not furnish much information about the actual direction of the current, but more exact work with proper appliances reveals much more, and we are able to trace, step by step, the exact course of a stream of water through the tiny openings or pores in the skin of the sponge to the central cavity—in fact, to establish a definite canal-system which may be regarded as the circulatory system, commencing at the pores and ending at the outlet at the top of the sponge through what is known as the *osculum*. In man the circulatory system is a closed one, in the sponge it is open; in man oxygen and nutrient

material are carried to every part and parcel of the body by means of the circulatory system ; in the sponge, the sea water courses through the canal-system, carrying not only the oxygen which is necessary for the continual oxidation of every part of the sponge, but also particles of nutrient material which will ultimately be absorbed by the special cells set apart for digestive purposes.

And this leads us to ask for a more detailed knowledge of the system concerned in the alimentation of the sponge. Some of the necessary details for this knowledge can be gained by recourse to a few thin sections cut transversely with an ordinary razor through one of the cylindrical sponges. If these sections are placed in a shallow vessel the central gastral cavity is at once apparent, and radiating from it towards the margin of the section thimble-like spaces are seen, whilst between adjacent spaces is a thin texture of gelatinous material in which are embedded spicules of lime of various shapes and sizes matted together in a definite manner to form a support to the spaces lying near it. The special arrangement of the spicules, like links in a suit of chain-armour, to form the skeleton, allows, as we shall see afterwards, of a free course to any water entering or leaving the sponge. For the present we must leave the consideration of the skeleton and confine our attention to the part played by the thimble-like chambers in the very necessary duty of keeping the sponge alive. Our rough sections will not furnish the necessary details, but if by special methods of staining and embedding in paraffin we are able to obtain sections the 1-1000 in. thick, we see at once that these chambers are lined by a very specialized kind of cell, known from peculiar appendages it possesses as a "flagellate collared cell," and giving to the chambers to which they are confined the name of flagellate chambers.

These collared cells play such an important part in the economy of sponges that we must have a very clear con-

ception of their structure before we can enter, with intelligence, into the everyday-life of such a sponge as we are now considering. They are exceedingly minute in size, so small that from 5,000 to 10,000 of them placed close together side by side would only form a line one inch in length, and yet so wonderfully formed as to be able not only to capture the food particles, but also to digest the same in a manner analogous to the digestive cells of animals infinitely removed from them in the animal kingdom. Typically, a collared cell consists of a rounded or sometimes cylindrical body produced above into a neck. The neck is surmounted by a comparatively long vibratile whip-like flagellum which is surrounded by a very delicate transparent membranous collar which is usually more or less funnel-shaped and inserted in the neck around the flagellum. In the body of the cell is a specialized part of the protoplasm, which shows a great affinity for the staining material used in the preparation of the section, known as the nucleus, and lying near to it are one or two open spaces called contractile vacuoles. As far as I know, these collared cells have never been seen in the act of feeding in the sponge itself, but there is an animal (*Monosiga gracilis*) belonging to the great division of the animal kingdom known as Protozoa or one-celled animals, which is almost identical in structure to the collared cell of the sponge, and the feeding habits of this form have been very carefully observed. When in action, the flagellum projects freely through and beyond the cavity of the funnel-shaped collar, and being in constant movement to and fro with a swinging motion causes a current of water whose general direction is towards the collar. By means of this current the animal secures its food. All sorts of minute particles are carried against the collar. These particles, however, do not remain stationary in the spot where they come into contact but are carried irresistibly up the outside of the funnel to the edge of the opening,

then over the edge and down the inside till they reach the body of the animal at the bottom of the funnel when they are engulfed in the soft protoplasm; the nutrient material is taken up by the protoplasm, and the waste matter probably excreted by means of the contractile vacuoles.

We are now in a position to understand a few more details about the canal system of the sponge. We have already learned that the water enters through minute pores in the outer layer, and that, somehow or other, it finds its way through the fairly thick wall into the central cavity. The wall, as we have seen, is made up of the flagellate chambers together with the gelatinous material and embedded spicules which form the boundary or supporting structures to the chambers, and the water passes freely through the wall in a very definite course. Why does it take that course? Minute examination of the wall of the flagellate chambers elicits the fact that at intervals between the collared cells which make up the wall small holes or prosopyles occur through which water can easily pass when impelled to do so by the violent movement of thousands of the minute vibratile processes of the collared cells. This accumulated movement is the motive power of the current. As the water sweeps through these tiny holes and bathes the wall of the chamber studded with the cells the food particles are detained by the protoplasmic collars and by them transmitted to the digestive portion of the cell. The water thus robbed of its nutrient material, and bearing with it the rejected portions of the food particles, passes through the chamber to join the general current which issues from the *gastral* cavity at the top of the sponge. To summarize the course of the current we may refer to its entry by the pores and so into minute irregular channels, inhalent canals, which penetrate the gelatinous material and reach the wall of the flagellate chambers; then through small holes or prosopyles

pyles in the wall of the chambers; then through the chambers and out by exhalent canals into the gastral cavity, and so, finally, to the osculum at the top of the sponge. That, in short, constitutes the canal-system of practically every sponge. Modifications, of course, occur in the different groups and subgroups. In some, the inhalent canals are long whilst the exhalent canals are short, and vice versa; in others, the flagellate chambers are spherical instead of cylindrical, being served direct with an inhalent and exhalent canal. But, in all, the same plan holds—an inhalent current carrying oxygen and nutrient material and an exhalent current bearing away the water poor in oxygen and laden with excretory products of digestion.

It is easy to conceive how a very much more complicated canal-system could have arisen if we imagine the ordinary cylindrical form to have sent out branches; and these, in turn, to have also produced branches, giving rise to a colony of *Sycon* sponges. Further, if we imagine fusion to have taken place between contiguous branches and stem, and also a common envelope to have enclosed the branching cylinders, we have presented so intricate a circulatory system as almost to baffle interpretation—millions of inhalent pores and hundreds of exhalent openings, such as is familiar to us in the common bath sponge *Euspongia*.

Before finally leaving the consideration of the canal-system one point of special interest may be mentioned in connection with the flow of water from the flagellate chambers. In some forms (e. g., *Grantia labyrinthica*) the exhalent canals are furnished with minute diaphragms, working on the principle of the iris diaphragm. In sections, these are found with varying degrees of aperture showing that under special stimulus the so-called muscle cells which are closely connected with the diaphragms offer some kind of control in closing the apertures for the escape of water from the individual chambers, and so as-

sist in regulating the current of water flowing through the sponge at large.

As a kind of working classification based on the canal-system of the calcareous group the following may be suggested because the sponges included in it are easy to obtain locally and are convenient to manipulate. But, as is well known, the canal-system alone cannot be relied upon to furnish a truly scientific classification, but it will serve a present purpose in affording a kind of focus in connection with which can be gathered the more important facts which have guided spongologists in adopting a more elaborate arrangement. The attention of those who wish for further information on the classification of this group is directed to the Synopsis drawn up by Professor Dendy and published in the "Proceedings of the Royal Society of Victoria," vol. v. (new series). Subjoined is a simple working classification alluded to above:—

CALCAREOUS GROUP.

Order I.—**HOMOCŒLA**, in which no flagellate chambers are present, but the collared cells are confined to the gastral cavity. Exs. *Leucosolenia stolonifer*, *L. stipitata* and *L. pulcherrima*.

Order II.—**HETEROCŒLA**, in which the collared cells are confined to the flagellate chambers.

Family I.—The flagellate chambers project freely.
Ex. *Sycon raphanus*.

Family II—The flagellate chambers are enclosed by a cortex. (1). With radiate arrangements of chambers. Ex. *Sycon gelatinosum*. (2) With chambers scattered irregularly. Ex. *Vosmaeropsis macera*.

The names in the above list do not convey any idea of the shape and size of the specimens selected as examples, and it will be well, therefore, to state a few simple facts in regard to their external appearance and habits of growth as aids to discovery and identification, since one specimen gathered and identified is of more practical value

than mere theoretical knowledge gained from twenty pages of a museum catalogue.

The first named in the list is *Leucosolenia stolonifer*, and a more useful sponge can scarcely be found for our first study, because of its extreme simplicity of form and structure. We are fortunate in having so simple a sponge so close at home. It consists of a colony of three or four very thin walled tubes springing vertically from a slender rootlike bar of sponge tissue running horizontally along the surface of the weed to which the colony is attached by down-growing processes. Each tube reaches a height of about $1\frac{1}{2}$ inches, having a thickness of $\frac{1}{4}$ -inch. At the very top of the tube is the osculum for the outgoing stream of water. A thin section across one of the tubes shows an extremely thin wall pierced by pores which communicate directly by means of narrow canals, with the central cavity which alone is lined by collared cells. The existence of the simplest possible canal-system and the absence of flagellate chambers render this sponge especially acceptable to a novice in spongology. There is little to learn about it, but this little must be learned before any real progress can be made with the anatomy of the more complicated forms. The sponge, unfortunately, is not of common occurrence, only one specimen, creamy white in color, being captured during the visit; and that one was found attached to a piece of seaweed floating in with the incoming tide.

Closely allied, in relationship, to *L. stolonifer*, but differing entirely from it in appearance, is *L. stipitata*, found in considerable numbers attached to the under surface of loose stones. Its somewhat oval body is fixed to the stone by a short slender stem—body and stem together measuring somewhat less than $\frac{1}{2}$ -inch. The sponge is built up of a complicated system of branching and anastomosing tubes, each of which is of the same type of structure as the simple tube of *L. stolonifer*. When viewed, under the

lens, the wall is seen to be pierced with fairly large holes or pseudo-pores, and on the top ridge a single osculum usually occurs. The arrangement of the spicules which form the skeleton can be easily seen if the sponge is rendered transparent and mounted for microscopical examination.

A few examples of *L. pulcherrima* are also to be found living side by side with *L. stipitata* to which they are very similar in size and appearance.

In order to collect specimens of these small sponges the stone to which they are attached should be placed in water just deep enough to cover the surface of it. The sponges then take up a vertical position which allows them to be readily seen and removed.

Leaving the Homocœla group we take for our next consideration *Sycon raphanus* which furnishes a higher type of canal-system than the examples we have already studied. The body of this sponge, pine-apple in shape, is perched on a short stalk which anchors it to the stone upon which it grows. In height it is usually less than $\frac{1}{2}$ -inch, and it occurs singly or in colonies (see Fig. A), each colony furnishing individuals in all stages of growth. Growing very close to the surface of the stone it is usually almost covered up with sand. This can be got rid of by removing the sponges to a small bottle of sea water or methylated spirit and gently shaking the same; successive changes to a fresh supply of water or spirit soon render the sponge fit for examination.

If a thin transverse section is examined it shows at once that the sponge owes its characteristic pine-apple appearance to the fact that the ends of the flagellate chambers which are developed as outgrowths from the central cavity, project freely to the exterior and are protected externally by a special arrangement of one-rayed spicules which stand out like stiff spines. Each chamber is built upon the same plan as our simple type of sponge (*L. stolonifer*),

but in place of a simple tube with its one exhalent opening, there are here hundreds of simple tubes, not leading an independent existence but all connected with and opening into one central cavity, which, in turn, opens to the exterior by one osculum. The water enters directly into the flagellate chambers by means of prosopyles which occur freely in the part of the wall exposed to the sea; then it flows through the chamber and so into the common central cavity, finally passing out of the sponge by the osculum at the top.

If sponges of this species are gathered in the summer, scores of embryos will be found embedded in the gelatinous material supporting the chambers or even in the chambers themselves, and anyone wishing to study the embryology of a sponge cannot do better than commence with *Sycon raphanus*. For this reason I have figured and described the various stages (see frontispiece) in the development of such a sponge, nearly all of which can be followed without much difficulty. The best methods to employ in such investigation can be obtained from text books which treat of special microscopic technique.

The next sponge on our list is *Sycon gelatinosum*, often known under the name given to it by Haeckel, as *S. arborea*. This is a very common species in Australia and is very variable in form, being either colonial or solitary. The solitary form, about an inch in height, is found attached to the under surface of stones; whilst the colonial form, which consists of tubes very richly branched, reaches a height of 2 or 3 inches and is found growing amongst the sea-grass on the ocean side of the reef at Flinders. In color these sponges are a creamy white and in some a fringe of spicules surrounds the oscula whilst in others it is absent.

A single tube or branch of the colonial form represents a single individual of *S. raphanus* and if we examine a transverse section of such a tube we notice that the cham-

bers have a radiate arrangement as in *S. raphanus* but the ends do not project freely as in that form but are enclosed in a cortex which is continuous from chamber to chamber. The presence of this cortex necessitates some change in the canal-system and we find special pore-areas in it through which the water enters. The pores lead into inhalent canals which communicate directly with the prosopyles in the walls of the flagellate chambers through which the water flows; the chambers open by means of very short exhalent canals in the *gastral cavity*, and the stream of water passing out of each chamber is regulated by the opening and closing of a diaphragm with which each chamber is furnished.

The last example of the group to be considered is one named *Vosmaeropsis macera*. This sponge is something like *S. gelatinosum* in appearance, but the tubes are more densely agglomerated, the numerous individuals being almost completely fused together. We take this form for examination because of the modification of its canal system as compared with the last example. Here the chambers are thimble-shaped, but they are scattered somewhat irregularly between the dermal cortex and the *gastral cavity*, and as they lie at some distance from the *gastral cavity* communication is effected by means of long exhalent canals, whilst in *S. gelatinosum* these canals are short.

The calcareous sponges described above do not, of course, exhaust the list of the Flinders specimens. They have been described in some detail because they show the development of the canal-system from the simple type of *L. stolonifer* to the more complex one of *V. macera*, and they show it in an unmistakable manner.

Reference has been made, again and again, to the presence of spicules. They lie in the mesodermal tissue of the sponge, each being developed from a single cell, the scleroblast, and are composed of carbonate of lime, and give strength, support and protection to the softer tis-

sues. Three main forms can be distinguished:—The triradiates, which consist of three rays or arms radiating from a common centre; the quadriradiates with four rays, the fourth ray projecting from the centre of the spicule in a plane at right angles to that of the other three; and the oxeotes which consist of a simple rod usually spindle-shaped and pointed at both ends. Specimens of the various kinds of spicules can be obtained either by tearing up a piece of sponge with needles or by boiling sponge tissue with a little potash.

A few lines may be given here in reference to some interesting fossil forms of members of this group occurring at Flinders. About a mile westward of West Head, near the bathing boxes, a small cliff-section of limestone rock of Eocene age is within easy reach, where, mixed with fragments of polyzoa, echinoid tests and brachiopoda, several varieties of sponges occur. Examples of these were lately forwarded by Mr. T. S. Hall, M.A., one of the vice-presidents of this Club, to Dr. G. J. Hinde, F.R.S., who in the *Quart. Journ. Geol. Soc.*, vol. lvi., describes them as belonging to three new species. Two of them require new genera for their reception, namely, *Plectroninia* and *Tretocalia*, whilst a third form is referred to a genus, *Bactronella*, which occurs in rocks of Jurassic age in Europe. The state of preservation of this latter form enables Dr. Hinde to add to our knowledge of the genus. *Plectroninia* is interesting in that it belongs to the group of calcareous sponges with fused spicules which so far is known to contain only this genus and a recent Japanese form, the two together forming the group *Lithonina*. *Tretocalia* and, possibly, *Bactronella* seem to be *Pharetrones*, but better preserved specimens from clay beds are wanted to settle the point. *Pharetrones* were supposed to have become extinct at the close of the Mesozoic period, but here we have some Tertiary ones, while Professor Dendy regards one of our recent Australian genera,

the *Lelapia*, as a living representative of the same group.

Further details as regards the anatomy of many of the local forms of calcareous sponges can be obtained from the articles by Professor Dendy published in the Proceedings and Transactions of the Royal Society of Victoria and the Quarterly Journal of Microscopical Science.

We commenced with the question, Are sponges animals or plants? and our examination of the circulatory and digestive system indicates their animal status. But the most convincing evidence, placing them, without doubt, amongst the animals, comes from a study of their development. In this they are distinctly holozoic. That we may learn a few facts about the general principles of sponge development it will be well to take as a type *Sycon raphanus*, because it is easily obtained, and, in the summer season, is usually well provided with embryos in every stage of development. These stages may be noted :

(1). Reproductive cells are formed from cells in the mesoderm of the sponge and the productive elements—male and female—are fashioned from them. The male elements or spermatozoa are formed by the division of these reproductive cells into a large number of parts each of which develops a head and tail, whilst the female cells or ova become somewhat spherical in shape and are furnished with a large nucleus.

(2). The ova of one sponge are probably fertilized by the spermatozoa from another and then commence to develop in the mesoderm of the mother sponge near the walls of the flagellate chambers.

(3). Each ovum begins to divide in an orderly manner into 2, 4, and 8 parts, and so on—the cells at the upper pole being somewhat columnar in shape whilst those at the lower pole are spherical and granular. (A. 1, 2, 3, 4.)

(4). A little later and these layers are clearly marked off from each other with a cavity between them and the blastosphere stage is reached. (A. 5.)

(5). A little later and the granular cells become pushed in towards the columnar cells. This is probably due to the position in which the embryo is lying—the granular cells being bounded by spicules whilst the columnar cells are free to expand. This is known as the *pseudo-gastrula* stage. (A. 6, 7.)

(6). About this time the embryo bursts through the wall of the flagellate chamber; the granular cells are pushed out again and the embryo has the form of a hollow sphere (see B. and B. 1). The columnar cells now produce cilia and the embryo, by their means, is free to move in the water. This is known as the *amphiblastula* stage. (B. 2.)

(7). True invagination now takes place, the columnar cells being pushed in whilst the granular cells are arranged in a single layer outside and the segmentation cavity reduced to a mere slit. This is the *gastrula* stage. (B. 3.)

(8). A little later and the embryo attaches itself by its open end to some foreign object. The outer granular cells become flattened, the columnar cells lose their cilia and a gelatinous layer is produced between the other layers. Three distinct layers are, therefore, now present—ectoderm and endoderm with a layer of mesoderm between. (B. 4.)

(9). The next stage consists in the elongation of the embryo into a tubular form when it becomes flattened at the top and perforated by an osculum. The walls are pierced by pores, spicules appear in the gelatinous layer and the ciliated cells developed into collared cells. This is known as the *olynthus* stage. (B. 5, 6.)

(10). Special chambers are gradually budded out from the *gastral* cavity and the collared cells become restricted to these chambers, the *gastral* cavity being lined by a layer of flattened ectodermal cells.

From the Victoria Naturalist, August, 1900.

Notes on Microscopy.

F. SHILLINGTON SCALES, F.R.M.S.

MR. C. BAKER'S NEW CATALOGUE.—Mr. Charles Baker has sent out his new catalogue, which is increased in size by about twenty pages. It contains particulars of his latest instruments, such as the R.M.S. 1·27 microscope, the D.P.H. Nos. 1 and 2, the Diagnostic, and the Plantation microscopes. The newest pattern microtomes, are also included. The list of stains, mounting media, and other accessories, is exceptionally complete and well arranged. Two or three pages are devoted to pond-life apparatus, but the extra pages are mainly taken up with lists of microscopic slides, arranged mostly in series at a moderate price, though the price of individual specimens seems rather higher than usual. The lists of bacteriological and diatomaceous slides call for special notice.

R. & J. BECK'S NEW "LONDON" MICROSCOPE.—In design of microscopes our English makers have always taken the lead, but the cheaper kind of Continental stand has had a large sale here, especially amongst our medical and other students. Recognizing this, Messrs. Beck, by laying down new plans for displacing hand labor by machinery in accordance with the practice of the day, have been able to put upon the market a new stand in which sound workmanship is combined with cheapness. The stand follows largely the Continental model, but is sold at a considerably lower figure than any similar Continental stand known to us. The essential features are as follows:—The stand is of the horse-shoe form, but the central pillar is placed farther forward under the stage so as to give greater facility when the microscope is in a horizontal position. The base itself actually rests on three inserted cork pads, which not only give steadiness, but prevent any possibility of scratching the table. The coarse adjustment is by spiral rack and pinion, whilst the fine ad-

justment is of the micrometer screw type, in which, however, a pointed rod impinges upon a hardened steel plate, which is itself attached to the limb of the microscope and works upon a triangular upright rod. In the larger model the milled head of the fine adjustment is graduated and furnished with a folding pointer. The body tube is designed for use with objectives corrected for the Continental length of tube, but carries a draw tube capable of variation from 140 to 200 millimeters. The stage is square and the upper surface is faced with ebonite. In the larger model it measures 4 x 4 inches. In the least expensive model a ring, of the Society size, is fitted beneath the stage to carry the iris diaphragm and condenser. The latter is especially arranged to fit above the iris diaphragm, and the arrangement is both effective and cheap. In the larger models, or those fitted with more elaborate sub-stage arrangements, the usual form of Abbe condenser is provided for in this instrument. Messrs. Beck make their "London" microscope in two sizes. The smaller size with sub-stage ring and iris diaphragm, but without objectives, eyepieces, or condenser, costs, with mahogany case, only \$16.00. The addition of a swing-out and spiral focussing sub-stage increases the price to \$19.50. The larger model, similar to the last described, costs \$25.50, or with rack and pinion focussing sub-stage \$31.60. The necessary eyepieces cost \$1.25 each, the condenser in its simplest form \$2.40, whilst the objectives are of Messrs. Beck's well-known and moderately priced series.

DEVELOPMENT OF *BALANUS*.—On the rocks of the southern and western coasts of England, when the tide is out, we observe that their surface is roughened up to a certain level with an innumerable multitude of brownish cones. Each appears as a little castle built of strong plates that lean towards each other but leave an orifice at the top. Within this opening we see two or three other pieces joined together in a particular manner, but capa-

ble of separating. These are Barnacles, class Crustacea, division Cirripedia (from cirrus, a curl, and pes, a foot), order Balanidæ (from balanus, an acorn). Fixed and immovable as barnacles are in their adult stage, they have passed by meta-morphosis through conditions of life in which they were roving little creatures, swimming freely in the sea. It is in these conditions that they present the closest resemblance to familiar forms of crustacæ. The Nauplius stage of the barnacle has a broad carapace, a single eye, two pairs of antennæ, three pairs of jointed, branched and well-bristled legs, and a forked tail. The skin is cast twice, considerable change of figure resulting. At the third moult it assumes the cypris stage, and is enclosed in a bivalve shell, with the front of the head and the antennæ greatly developed, the single eye having become two. In this stage the little creature searches for a suitable spot for a permanent residence. The two antennæ which project from the shell pour out a glutinous gum which hardens in water and fixes them. Another moult takes place, the bivalve shell is thrown off, the carapace is composed of several pieces, whilst the legs are modified into cirri and made to execute their grasping movement. Nothing can be more effective or beautiful than the manner in which the cirrus obtains its prey. The cirri are alternately thrown out and retracted with great rapidity, and when fully expanded the plumose and flexible stems form an exquisitely beautiful apparatus, admirably adapted to entangle any nutritious atoms or minute living creatures that may happen to be present in the circumscribed space over which this singular casting-net is thrown, and drag them down to the vicinity of the mouth. This action may be easily seen if a small portion of rock be chipped off, having barnacles on it, and placed in a glass with sea-water. A hand-glass will show the beautiful little hand with twenty-four long fingers, the net with which this fisher takes his prey, busily at work. Care

must be taken that there are living barnacles on the piece of rock, as many are but empty shells. An interesting slide is *Obelia geniculata*. It has double and alternate generations. The polyp bears urn-like reproductive capsules which discharge large numbers of medusiform zooids. Like miniature balloons they float suspended in the water for a while, and then suddenly start into motion with a series of vigorous jerks. They may be considered as swimming polypites with the arms united by a contractile web. They mature and disperse the generative elements, and, having thus fulfilled their function, perish. The ova, after fertilization, become ciliated embryos, and when affixed rapidly grow into the plant-like zoophytes we see. *Sertularia pumila*—another hydroid zoophyte—is a very common species, though it makes a very beautiful microscopic object. Almost every broad-leaved seaweed has greater or lesser numbers of this zoophyte growing on it. *Coryne vaginata* is one of the Athecata—that is, without any theca or calycula. The capitate tentacles bear on the summit a globular head consisting of a collection of thread cells, a vigorous battery of offensive weapons. They occur in astonishing profusion, and consist of minute sacs embedded in the flesh, filled with fluid, which contains a long delicate thread capable of being projected with considerable rapidity. *Corydendrum parasiticus* is a creature similar to the last, but the tentacles are not capitate. There is something singular about the stems that supported the polypites; they look as if they acted as capsules and held ova. This is a foreign species, and I cannot find any description of it. I believe Mr. Sinel told me it came from the Mediterranean. *Pennaria carolina* is also a foreign species. Some of the polypites bear gonophores, the buds in which the reproductive elements are formed.

GLYCERINE MOUNTING MEDIA.—In using it is well to remember, as pointed out by Dr. Carpenter, that they large-

ly increase the transparency of organic substances; and though this is often advantageous, it may also sometimes result in so great a diminution of their reflecting capacity as to make them indifferent mounts. We have given such instructions in elementary mounting as will, we think, enable a beginner to make rapid progress in the art if he is gifted with only a small amount of perseverance and patience, but it must not be forgotten that the actual mounting is but a part of the work required. Numerous subjects will need very careful preparation beforehand, and on the methods adopted and the skill and judgment with which they are carried out will depend much of the result. Many objects will need dissecting. Most dissections, and especially delicate dissections, are done under water, with perhaps a little methylated spirit added if the object has previously been soaking for some time in methylated spirit or alcohol. In some cases it will be necessary to fasten the object down, and this may be done with pins on a weighted piece of cork placed inside the dissecting dish, or by running paraffin or some such compound into the bottom as already explained. Watch-glasses with flat bottoms make useful dissecting dishes. Two or three needles set in light wooden handles will be required, with both straight and bent points, and these can readily be manufactured at home, or purchased for a few cents. In buying dissecting knives, we strongly recommend that those with ivory handles be chosen; they only cost one shilling and nine-pence each, as against eighteen-pence for the ebony-handled ones, while the latter are so brittle as to break with very little pressure. There are a good many shapes of blades sold, but perhaps the most generally useful are the usual scalpel forms, the spear, and the spatulate-shaped ones. Forceps may be either steel, brass, or nickel, but we prefer the steel, which should, of course, be carefully kept clear of rust. A few camel-hair brushes are also necessary, and a pair of fine scissors. Insects gen-

erally require soaking in a ten per cent solution of sodium of potassium hydrate (caustic potash), for periods varying from an hour or two up to a week. Too much soaking will destroy the object and also render it too transparent after mounting, whilst too little may leave it hard and difficult to deal with. A little thought and attention will therefore be necessary, and a slight pressure with a blunt needle will tell whether the object is sufficiently soaked. In the case of large insects, like cockroaches, we should soak them for several days until they begin to give off an unpleasant smell. The alkali must then be removed by soaking in several changes of clean water. The inside of the insect can be got rid of by gentle treatment with the camel-hair brushes. Plant subjects are best softened by long soaking in water.

PARASITES IN THE BLOOD.—Dr. Leon S. Le Wald, of New York City, spoke on this subject, dwelling particularly on the very recent interesting experiments in regard to the relation of mosquitos to malaria. He said that Drs. Manson and Ross, of England, had proved within the last month most conclusively that malaria was transmitted to the human subject by mosquitos. Mosquitos raised in the laboratory, and known to be free from malarial infection, were allowed to suck the blood of a person in Italy suffering from malaria, the type of which had been determined by microscopical examination of the blood and identification of its contained parasites. These mosquitos were then sent to London and allowed to bite Dr. Manson's son, a young man who was perfectly healthy at the time, and free from malaria infection. He promptly developed, on September 13, 1900, the characteristic signs of true malaria, and examination of his blood on September 16th showed many tertian parasites—the same form present in the blood of the Italian. After a few days, quinine was administered freely, and in two days more these

parasites had disappeared. A week later the young man was well again. Another interesting experiment conducted this summer was that of Drs. Sambon and Low, who took a hut with them to the most intensely malarial section of the Roman Campagna. Here they lived for several weeks without developing malaria, although newcomers to that region almost invariably became promptly infected. All that they did was to remain in the house between sunset and sunrise, and took unusual precautions to prevent being bitten by mosquitos at any time while there. The connecting link between these two most important experiments was to be found in the discovery within the bodies of these mosquitos, known to transmit malaria, the flagella, thus demonstrating beyond all doubt that the mosquito is the intermediary host of the malarial parasite. It should be noted that this statement applied only to certain species of mosquitos, and this explained the fact that malaria was unknown in many places where ordinary mosquitos were abundant.

BIOLOGICAL NOTES.

L. H. PAMMEL.

POLLEN IN MAIZE.—In a recent bulletin of the Division of Vegetable Physiology and Pathology, Dr. Herbert J. Webber discusses the interesting subject of Xenia or the Immediate Effect of Pollen, in Maize. A great deal of work has been done on the immediate effect of pollen in maize, but the experiments given by Devries and Correns in which attention is called to the fact that double fecundation probably explains the phenomena of Xenia. And it is interesting to note that in July, 1899, the same explanation seemed probable to Webber. And during that summer quite a number of experiments were conducted with a view to obtain evidence on this question. Double fecundation was first observed in *Lilium martagon* and

Fritillaria tenella, and later Guignard gives a description of this phenomenon in greater detail.

In his excellent review of this subject, Webber says: "Previous to these discoveries it had been supposed that in fecundation only one of the two generative nuclei which are formed in the pollen tube of seed plants passed over into the embryo sac and united with the egg cell proper. Nawaschin and Guignard have shown however that both of the nuclei enter the embryo sac, one fusing with the nucleus of the egg cell and the other with the two polar nuclei to form the embryo sac nucleus, the division of which gives rise to the endosperm. If this double fecundation occurs in hybridization, it will be seen that the endosperm developed from the nucleus of the embryo sac must be of hybrid origin."

In regard to the phenomena of *Xenia*, Dr. Webber further states: "While it has been claimed that *Xenia* is a somewhat common phenomenon in many plants, there are very few cases on record that are not open to some doubt; but in no plant is its occurrence so well substantiated as in maize. Indeed, the entire belief in the existence of *Xenia* may be said to depend upon its occurring in this plant. That corn crosses readily in the field and shows the effect the first year is a generally recognized fact among agriculturists in this country. The majority of the cases reported, however, are open to the criticism that the seed planted was not definitely known to be pure, and thus the supposed immediate effect of crossing might be explained as due to hybridization which occurred the previous year, or might possibly be interpreted as cases of reversion."

This paper of Webber's gives not only a great deal of evidence on this whole subject but is accompanied by several unusually good plates. (Bull. Div. Veg. Phys. and Path., 22).

FRAGRANT YEAST.—Mr. B. T. P. Barker in a recent paper describes a fragrant yeast *Saccharomyces anomalus*

Hansen) found in connection with the fermentation of ginger. The organism in its appearance and manner of growth seemed to be a form of so-called *Mycoerma*. Primary films of this organism occur on the culture medium in twenty-four to forty-eight hours, later becoming a greasy wrinkled film. Secondary films make their appearance some time after fermentation has ceased. In young vigorous cultures the cells are almost entirely ellipsoidal or slightly egg-shaped, vacuoles appear when the cells have finished their active growth. Spores are formed very readily. In order to germinate, the spores must be fully ripe. The spore begins to swell in about twenty-four hours after souring at 18 °C. The spore becomes more transparent, it swells till about twice the original size of the spore. It then develops a bud on this surface. The optimum temperature is 28 °C. but growth takes place between 15°C. and 32°C. It is slow at 10°C. and killed at 55°C. for five minutes. It produces alcoholic fermentation in xylose, mannate, umacacia, dextrin, lactose, maltose, soluble starch, dextrose, saccharose and laevulose.

CHROMOGENIC MICROCOCCUS.—Miss Mary Hefferan in the course of an examination of river water from the sanitary District Chicago found a chromogenic micrococcus. This water is plated in Hayden Agar which is a much better medium for bringing a large number of bacteria to development than ordinary peptone agar. At the end of ten days the Hayden and peptone agar present colonies in the ratio 21 : 400. The particular organism only developed on the Hayden agar. The writer compares this organism with other known red micrococci. The name *Micrococcus roseus flavus* is given.

SEED BURYING AWNS.—L. Murbach presents an interesting account of the mechanics of the seed-burying awns of *Stipa avenacea*. The cause is found in the thick-walled

mechanical cells of peculiar structure of varying chemical composition. The awn is strongly twisted over half its length, beginning at the lower end, in a direction opposite to the movement of watch hands. The remainder of the awn is without this spiral structure, but is bent at an angle to the body of the awn; this furnishes a brace or support when the seed begins its boring motion, driven by the alternate twisting and untwisting of the dry or wet awn. Muhrbach concludes as other observers have that not only a layer of cells, but all of the mechanical cells are active in bringing about the twisting. The twisted portion of the awn is composed principally of sclerenchyma cells with a fibro-vascular bundle in the center and a band of chlorophyll bearing tissue on each side. (Bot. Gazette, 30 : 113).

DIPHTHERIA.—Just now while there is some discussion on the subject of Diphteria bacilli in healthy throats, the conclusions of E. P. Denny are of interest.

“Diphtheria bacilli are seldom found (except where great exposure) in the throats of healthy individuals living under good hygienic conditions.”

“A large number of persons may be infected by healthy individuals who have the bacilli in their throats.”

“The conditions of institution life which favor growth of virulent bacilli in healthy throats are the massing of a large number of persons in limited air-space.”

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INDEX.

Acetylene, 19
 Adulteration, 160
 Agar-agar, 14, 46
Albugo bliti, 25
 Alcohol, 142
Alga, 59, 79, 235
 Allegier, W. W. 14
 Air-bubbles, 82
Amœba, 41, 275
 Aperture, 3
Aphis, 258
 Apparatus, 28, 58,
 61, 69, 90, 148, 172,
 229, 253, 255, 279,
 290, 323, 343
Artemia, 218, 322
Aspergillus, 44
Bacilli, 75, 98, 142,
 165, 170, 244
Bacillaria, 23, 24,
 101, 152
Bacteria, 33, 46, 97,
 111, 116, 142, 197
Bacteriology, 119, 164
Balanus, 344
Benzole, 59
 Biological notes, 25,
 45, 75, 110, 141,
 167, 188
 Blood, 128, 156, 193,
 348
 Book notices:
 Acetylene, 178
 Anat. Atlas, 169
 Bac. Pentland, 119
 Bacteriology, Di-
 rection, Moore, 352
 Botany, Atkinson,
 120
 Botany, Coulter,
 178
 Chats about the
 M., Shelley, 121
 Clinical Diagnos-
 sis, Simon, 326
 Lloyd Bulletin, 149
 Microscopy,
 Schneider, 145
 Blood, 21, 296
 Bones, 171
 Bouillon, 18
 Botany, Books, on,
 31, 120
 Bubbles, 133
 Camera, 264, 283, 311
Canada Balsam, 39,
 65, 118, 262, 323
 Carbolic acid, 79
 Carter, T. P. 93
 Casts, 12, 308
 Cells, 234
Celloidin, 50
 Cement, 48, 58, 79,
 261
Cementite, 284
Centrosomes, 189
Cherts, 209
Chlorophyll, 48
Chromatophores,
 168
Citrus, 110
Cleaning, 39
Clearing, 66
Collecting, 145, 192
Collodion, 7
Color illumination, 1
Condenser, 136, 146,
 209, 253, 292
Cone of Light, 3
Cooke, J. H. 48, 96,
 145, 171, 192, 264,
 296
Corpuscles, 21, 292
Crane, A. W. 164
Crown-gall, 168
Crystals, 80, 149, 193
Cultures, 76, 143, 351
Cunningham, K. M.
 181, 299
Cyclotella, 101
Cysts, 87
Deadblack, 195
Diamonds, 198
Diatoms, 22, 24, 79,
 89, 100, 151, 181,
 191, 195, 266, 299
Diatomaceous earth
 52
Diffraction, 8
Diphtheria, 352
Dissecting, 73
 Distillation, 48
 Draw-tubes, 71
 Drugs, 63, 159, 305
 Dust, 121
 Earthworms, 321
 Edwards, A. M. 22,
 24, 40, 101, 151,
 155, 211, 224, 271,
 275
 Embedding, 209
 Embryology, 27
 Epidermis, 198
 Eucaine, 247
 Fertilization, 190
 Fielder, W. 327
 Filter paper, 162
 Finders, 117
 Fish-food, 96
 Fish-teeth, 195
 Filtration, 52
 Fixing, 49, 93, 191
 Fluid mounts, 50
 Focussing, 173
 Foramenifera, 62,
 206
 Formaldehyde, 93
 Formalin, 49, 99, 128,
 254
 Fungus, 30, 81, 111,
 143, 155, 189, 191,
 195, 208
 Gas-light, 190
 Glass, 146
 Glycerine, 58, 324,
 346
Gomphonema, 43
 Great Salt Lake,
 217, 237
Gregarinida, 129
Hæmatoxylin, 65
Hæmoglobin, 194
Hairs of plants, 48
Hardening, 50
Haustoria, 144
Harris, Geo. T. 247
*Histological micro-
 scope*, 70
Histology, 100
Holborn & Angus,
 241

Holdfasts, 26
 Holoscopic eyepiece 28, 30, 113
 Hyalodiscus, 271
 Illumination, 1, 19, 49, 60, 73, 96, 134, 138, 172, 175, 193, 313
 Incubation, 35
 Infusoria, 22
 Insects, 118, 126, 162, 259, 260, 311, 321
 Jade, 114
 Killing, 93, 97, 98, 121, 196, 220, 247
 Kirby, William, 63
 Kizer, E. I. 128
 Klebs-Löffler, 165
 Labels, 99
 Lactic acid, 47, 170
 Lacquer, 147
 Lichens, 167
 Lieberkühn, 19, 174
 Light: see illum'n.
 Light filter, 286
 Malaria, 204, 287, 319
 Media, 64, 193, 261, 269, 346
 Melicerta, 91
 Merritt, W. H. 280
 Metals, 198, 280
 Micrococcus, 351
 Mica mounts, 62
 Micrograph, 146
 Microtome, 133, 198
 Micrometer, 21, 59
 Micro-photography, 171, 264
 Minerals, 98
 Milk, 179
 Mosquito 205, 187, 311
 Mosses, 62
 Mould, 30, 78, 149, 197
 Mounting, 13, 58, 64, 80, 116, 118, 128, 171, 191, 204, 206, 220, 228, 231, 233, 260, 298, 309, 324, 348
 Nails, 206, 248
 Nitrification, 47
 Norman, Albert, 249
 Nose-piece, 60
 Oakley, R. H. 83
 Objects, 32, 297
 Occidental sea, 22
 Ohler, W. H. 32
 Oil immersion, 89, 253
 Onyx, 114
 Oospores, 23
 Opaque objects, 173, 174, 233
 Ova, 230
 Ovipositor, 258, 260
 Pammell, L. H. 25, 45, 75, 110, 141, 167, 179, 188, 348
 Parasites, 259
 Penny, R. G. 310
 Penicillium, 78, 189
 Peridiniae, 224
 Petri dishes, 34, 38
 Peticolas, C. L. 182
 Photo-micrography 19, 90, 173, 194, 249, 310
 Plankton, 145, 192
 Plants, 76, 77, 78, 169, 189, 190
 Plasmodia, 48
 Podura, 314
 Polycystina, 88
 Pollen, 348
 Pond, C. J. 123
 Postal Club, 83, 114
 Postal Society, English, 226, 314
 Protista, 41, 107, 224
 Pus, 267
 Quekett Club, 30, 61, 112, 118, 197, 269, 353
 Radiolaria 87, 196, 211
 Realgar, 197
 Resolution, 99
 Rheinberg, Julius, 1
 Ringing, 325
 Roger's compressor 211
 Roots, 66
 Rotifers, 131, 196, 228
 Royal Mic. Society, 28, 61, 147, 256
 Rubiaceæ, 27
 Rusts, 26, 111
 Salmon, D. E. 199
 Scales, Shillington, 56, 69, 112, 129, 174, 204, 226, 253, 297, 319, 343
 Scales, mounting, 118, 257, 298, 314
 Screen, 172
 Sections, 63, 88, 93, 267
 Seibel, J. E. 44
 Silica standards, 51
 Slides, 32, 84, 89, 97, 148
 Slips, glass, 232
 Smuts, 45
 Societies, 28, 90, 118, 147, 208, 236, 255, 353
 Society screw, 177
 Sponges, 24, 30, 137, 327
 Sputum, 57
 Stains, 46, 30, 56, 128
 Staining, 57, 168, 171, 207, 241
 Standardization, 71, 81, 294
 Steel, 69, 89, 280
 Stems, 66
 Synedra, 109
 Talmage, J. E. 217
 Tele-microscope, 80
 Terry, Wm. A. 187
 Texas fever, 78, 199
 Ticks, 123, 201, 257
 Topping, Amos 130
 Trichina, 86, 97, 237
 Tubercle bacillus, 57, 110
 Tumors, 50
 Turnip, 46
 Type-plate, 188
 Urine, 12, 308
 Ustilago, 45
 Vibrioids of plant cells, 26
 Walmsley, W. H. 19
 Ward, R. H. 83
 Warm slide, 296
 Water bath, 296
 Whipple, G. C. 33, 51
 White, M. O. 156
 Wilt disease, 46
 Wood sections, 216, 165
 Xenia, 349
 Yeast, 141, 192, 350

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